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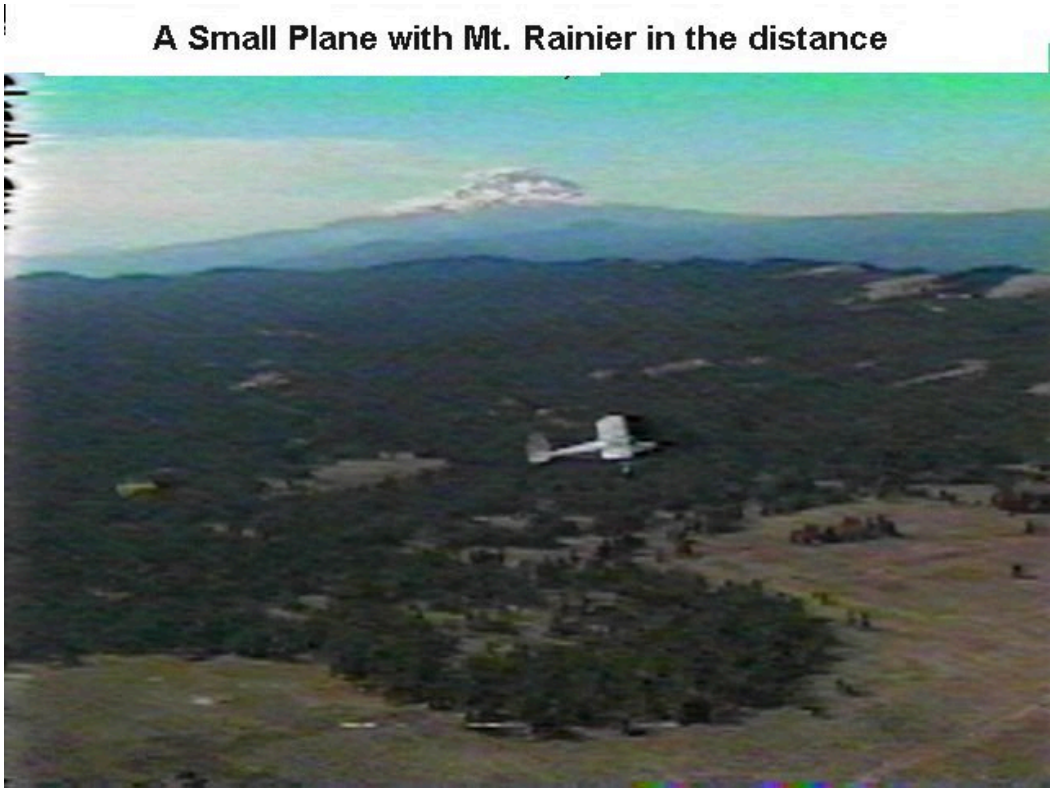
JUNE 24, 1947: HOW IT ALL BEGAN

The Story of the Arnold Sighting

by
Bruce Maccabee

(This document, the "ultimate Arnold" history and analysis, is an edited and updated - to March, 2002 - version of my presentation at the 1997 SYMPOSIUM OF THE MUTUAL UFO NETWORK at Grand Rapids, Michigan, July 12, 1997 on the occasion of the *FIFTIETH ANNIVERARY OF THE KENNETH ARNOLD SIGHTING* and of the ensuing burst of "flying saucer" sightings.)

(Note: at this symposium I performed the World Premier of "NEW AGE RISING", a solo piano composition commissioned (by me) in honor of the 50th anniversary of UFO sightings. Available on CD: **The Joy of Ivories**)



INTRODUCTION

June 24, 1947

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You will not find any conventional history book that even so much as mentions that on this date the human race first became aware of a phenomenon that could well be the most important discovery of the last century, or even in the history of mankind: the presence of "Other Intelligences" (Non-Human Intelligence). The important event of that date was the sighting, by Kenneth Arnold, of a group of strange flying objects which eventually became known throughout the world as flying saucers, Unidentified Flying Objects or UFOs (English, German, Japanese, etc.), OVNIs (Spanish, French) or NLOs (Russian).

Since Kenneth Arnold's story was publicized around the world over fifty years ago, sightings of UFOs/OVNIs/saucers have affected the lives of thousands of people the world over. So, why haven't history books mentioned this very important event? Because the subject of

flying saucers has been considered to be largely nonsense. Even though no one has yet offered a credible yet prosaic explanation for Arnold's sighting, it has been tacitly assumed by the the majority of the academic community, the community most likely to write history books, that Arnold's sighting, and the tens of thousands of others since his, have been explained in many ways.

This assumption by conventional historians is based on the fact that proposed explanations for Arnold's sighting, and for the other sightings, were widely publicized by the press, skeptical scientists and the U.S. Air Force. Historians, not having the necessary training in physical and perceptual sciences, could not properly evaluate these explanations and therefore assumed they were correct. Basically, they simply quoted "authorities" and didn't attempt to determine whether or not the authorities were accurate. The failure of the Air Force or any other government agency or group of people to provide for public evaluation some absolutely conclusive proof such as "hard evidence" (pieces of a saucer, aliens, dead or alive) meant that there was no compelling reason to question the explanations and so the explanations carried the day.... and the day after that.... and the day after that.... More than fifty years later these bogus explanations prevent June 24, 1947 from taking its rightful place in history. It is my intent in this paper to show how the explanations have failed. In doing so I hope to justify the inclusion of this day in future history books.

PRE - ARNOLD - HISTORY

Unknown to most of human society, during the spring of 1947 strange things were happening. Oddly shaped objects flying through the skies were seen by a few people. These appeared to be machines...but they weren't any type of flying craft made by mankind. They did not have aerodynamic shape, yet they traveled at high speed. The sightings were miracles of a sort...anomalous events with no explanation... a preview of coming events. The sightings were portentous occurrences, heralding the dawn of a new era, but the witnesses did not know this. They were the hadnwriting on the wall, but all the witnesses knew was that they had seen something strange. Probably some new development of the Air Force, they thought. After marveling at the sights, they forgot about them. These sightings would have been lost in the their distant memories, absent from history, if it hadn't been for one man and the events which followed his June sighting.

In January, 1947 a British Mosquito fighter aircraft chased an unknown flying object for half an hour off the coast of Britain. In April, in Richmond, Virginia, meteorologists saw round silvery objects fly past the meteorological balloons they were tracking. In May a pilot who lived in Oklahoma City saw a huge, shiny, disk-shaped object fly at a high speed and high altitude over him (he was on the ground at the time) without making any noise. During the same month seven employees of a railroad in Colorado watched a strange object perform strange maneuvers for several minutes. It looked metallic and it made no sound. Near the end of May a doctor who was fishing in South Carolina saw four discs which appeared to be spinning fly nearly overhead at a high rate of speed. They made no sound. There were a few other sightings in May and then the sighting rate began to increase in June. The newspaper reports compiled by Ted Bloecher (reference 8) are known to be an underestimate of the true number of sightings, but at least they give us an idea of what happened so long ago. According to Bloecher there was approximately one sighting every other day for the first half of the June. These were scattered over the midwest and western United States. Then the sighting rate doubled to about 2 per day until June 20. Bloecher found 3 sightings for June 20, two for June 21, three on June 22, six on June 23..... and then the explosion: Bloecher found 20 reports on June 24! These were mostly in the far northwestern states of Washington, Oregon and Idaho. Sightings were scattered throughout the day from morning to night. After the 24th the sighting rate stayed at about 10 per day or higher, with sightings occurring not just in the west but throughout the country. In early July the sighting rate climbed beyond 20 per day to 88 sightings on July 4, 76 on July 5, 156 on July 6, 159 on July 7, and a whopping 189 on July 8. After that it dropped quickly back to 20 per day and then only a few per day. By the end of July the sighting rate was about one per day and by August it was down to several per week. (Newspapers reported a few sightings in other countries as well.)

What had happened? Had the American people undergone a summertime "silly season?" Was there something in the air that made people see things that were not there? If you looked at the major national press for that period you would get the impression that the citizens of the United States had been spooked by some odd phenomenon which had burst upon the country with great speed and fury and had departed just as suddenly. After the 1947 flap was over there was no hard evidence - at least none available to the general public - to prove that any of the reported objects were real, i.e., solid, metallic objects. There were only stories and a few disputed photos. During the flap and afterward the U.S. government vehemently denied responsibility for any sightings and furthermore the Army Air Force claimed that a search for evidence of unusual flying craft had produced nothing. By early July explanations were running rampant and by late July the subject was being forgtten by all but the witnesses themselves.... and the Air Force and FBI. (Yes, the FBI did investigate sightings in 1947 and collected flying saucer information for years afterward. The "X files" are real! See ref. 12 and also elsewhere at this web siteCLICK HERE.)

During the first two weeks of the 1947 flap the press had a generally positive attitude

toward the sightings. There was a feeling that something had really been seen and there were two acceptable theories: advanced U.S. aircraft or enemy (Soviet) aircraft. But when the government denied having any such aircraft, and when it became apparent that the Soviets would be foolish to fly any advanced aircraft over the United States, the press became hostile to the idea that saucers were real flying craft. Instead saucer sightings were explained as delusions, motes in the eye, reflections off distant aircraft, ice meteors(!), misidentified natural phenomena and atmospheric effects such as mirages, hoaxes (of which there were a number) or just plain tall stories by people wanting notoriety. By the end of this period witnesses had been embarrassed and worse, ridiculed, by the stories in the press. New witnesses just decided to shut up. Even Mr. Arnold told the press that he would not report anything else he might see.

Of course, the subject of flying saucers did not die with the end of the flap. It just “went underground”...to pop up again and again in one form or another as sightings ebbed and flowed through the years following 1947. And, as students of the subject well know, the Air Force did not forget the sightings. For years there was a publicly known Air Force effort to analyze sightings (projects called Sign, Grudge and Blue Book). During Project Grudge the Air Force tackled Kenneth Arnold’s sighting. The Air Force in December, 1949, publicly claimed to have explained the sighting....but had not, as you will see. Nevertheless, the claim was enough to remove Arnold’s sighting from consideration by historians. (Even some pro-UFO books have suggested that Arnold saw a mirage.) Therefore, the reasoning went something like this: if the first major occurrence of a what appears to be a new phenomenon turns out to be faulty...then it is probable that any other similar reports are also faulty. And, by extending this logic to many other sightings that the Air Force claimed were explained (but weren't explained!) the whole subject was rejected by conventional science, the press and the history of the period.

However, as the following discussion shows, what was faulty was not the “first” sighting. What was faulty was the reasoning which led to various incorrect explanations.

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TOP VIEW OF Mt. RAINIER
As seen by passing Saucers

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THE ARNOLD STORY

THE SOURCES OF INFORMATION

Summaries of Arnold's sighting report have been published in a number of books (references 1,2,3,4,5,6,7,8,9) including his own (ref. 10). Unfortunately these books leave out some of the details that must be known in order to properly evaluate (and reject!) the explanations that have been proposed. I, too, do not have space to reproduce his sighting report (ref. 11) verbatim. However, I will present most of the information so that the reader will have a good understanding of what happened.

The Appendix contains a transcript of what was apparently the first radio interview of Mr. Arnold. This presents a very brief overview of the sighting as recalled the day afterward. Although the information contained therein is not used in the following reconstruction of the events, I present it here to show that his basic story had not changed over the weeks between the sighting and his letter to the Air Force, in which he presented his most detailed

recollections of his sighting.

WHAT WAS HE DOING BEFORE THE SIGHTING?

According to Mr. Arnold, at 2:00 PM, June 24, 1947 he took off from Chehalis, in the state of Washington, in his small plane after completing a business trip (he sold and installed fire fighting equipment). He planned to spend about an hour searching for a lost C-46 Marine transport plane that had crashed in the mountains west-southwest of Mt. Rainier. (There was a $5,000 reward for finding the plane.) After searching for about an hour and not finding anything he turned east toward his next destination, Yakima, Washington. He was near Mineral, Washington, about 22 miles west-southwest of Mt. Rainier and Yakima was about 80 miles ahead of him along a flight path that would take him just about 12 miles south of peak of Mt. Rainier. He levelled out onto his new flight path he was at approximately a 9,200 ft altitude. His sighting began within a minute or two of the turn. Sentences and paragraphs taken from his Air Force letter (ref. 11) are preceded by (L) and statements from his book (ref. 10) are preceded by (B). As you read the following story please keep in mind that this is history. It actually happened!

ARNOLD IN HIS AIRPLANE

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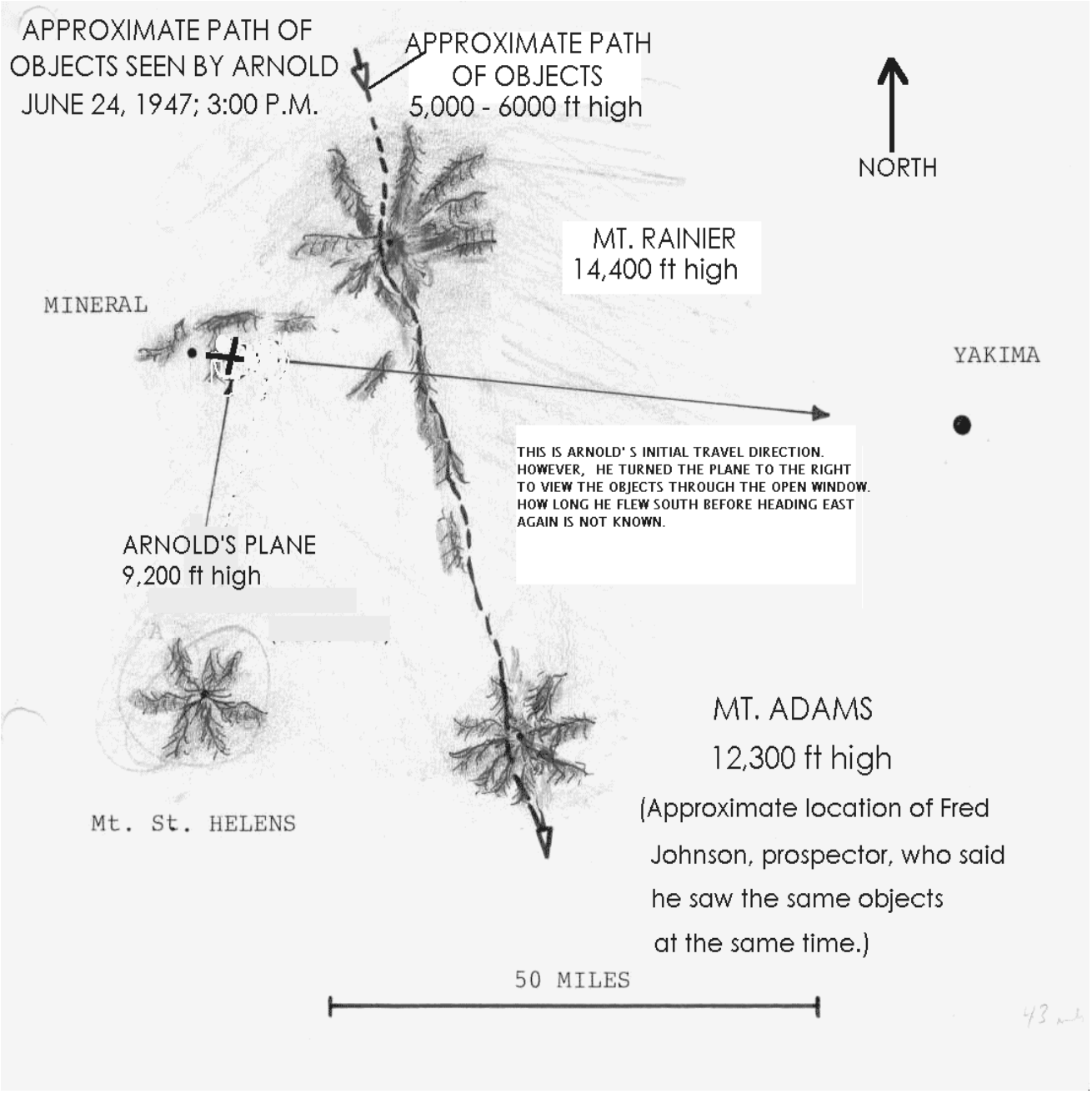
THE SIGHTING BEGINS

(L)"The air was so smooth that day that it was a real pleasure flying and, as most pilots do, when the air is smooth and they are flying at a higher altitude, I trimmed out my airplane in the direction of Yakima, which was almost directly east of my position and simply sat in my plane observing the sky and terrain. There was a DC-4 to the left and to the rear of me approximately fifteen miles distance, and I should judge, at 14,000 ft. elevation. The sky and air was as clear as crystal."

COMMENT: The time was about 3:00 PM and the sun was just slightly to the southwest of being directly overhead (azimuth 230 deg, elevation 60 deg.; this was only two days after the summer solstice). In what follows it is important to notice how Arnold's attention was first drawn to the presence of strange flying objects because his initial observation rules out any explanation that is based on things in the sky which are not shiny (reflective, like a mirror) such as, for example, birds. It also rules out atmospheric effects. Also, keep in mind the general geometry of this sighting. The objects traveled almost due south along a path that took them just west of Mt. Rainier. Their travel path from about the location of Rainier to several miles south of Rainier was essentially perpendicular to Arnold's eastward line of sight. This was at the time they were closest to Arnold.



(B) "It was during this search and while making a turn of 180 degrees over Mineral, Washington, at approximately 9,200 ft altitude, that a tremendously bright flash lit up the surfaces of my aircraft. " (Note that in his book, written about 4 years after the event, he puts the initial flash during the turn toward the east, whereas in the letter to the Air Force written several weeks afterward, see below, he indicates that he has completed the turn before he saw the first flash.)

(L) " I hadn't flown more than two or three minutes on my course when a bright flash of light reflected on my airplane. It startled me as I thought I was too close to some other aircraft."

(B) "I spent the next twenty to thirty seconds urgently searching the sky all around - to the sides and above and below me - in an attempt to determine where the flash of light had come from. The only actual plane I saw was a DC-4 far to my left and rear, apparently on its San Francisco to Seattle run. My momentary explanation to myself was that some lieutenant in a P-51 had given me a buzz job across my nose and that it was sun reflecting off his wings as he passed that had caused the flash. Before I had time to collect my thoughts or to find a close aircraft, the flash happened again. This time I caught the direction from which it had come. I observed, far to my left and to the north, a formation of very bright objects coming from the vinicity of Mt. Baker, flying very close to the mountain tops and traveling at tremendous speed.

(L) I observed a chain of nine peculiar looking aircraft flying from north to south at approximately 9,500 ft elevation and going, seemingly, in a definite direction of about 170 degrees.

COMMENT: Mt. Baker (altitude, 10,000 ft) is about 130 miles north of Mt. Rainier. Arnold indicates that they appeared to be "in the vicinity" of Mt. Baker. However, it is more likely that they were in the approximate direction of Mt. Baker, but much closer than Mt. Baker. Even if the objects were not as far away as Mt. Baker the flashes must have been very bright to be visible over a great distance. (If the path of the objects as estimated by Arnold, 170 degrees azimuth, is projected northward from Mt. Rainier, his sighting line to Mt. Baker crosses the projected path about 50 miles from his plane, which is a more likely distance for his initial observation of the flashes.) This suggests that the flashes were reflections of sunlight from mirror-like (specular) surfaces, i.e., a polished metal surfaces. Sunlight flashes could be visible over distances as great as a hundred miles under clear atmospheric conditions. Anything less would be invisible over such a distance in the bright sky. Since the sun was at an elevation of about 60 deg, some portion of the object's surface must have been momentarily at an angle of about 60 deg. to the horizontal in order to cause a reflected sun ray to travel nearly horizontally in the atmosphere from the object to Arnold's plane. Appendix 2 contains an analysis of the brightness of reflective objects seen under the daylight conditions reported by Arnold.

DESCRIPTION AND TIMING THE FLIGHT BETWEEN POINTS

(B) "At first I couldn't make out their shapes as they were still at a distance of over a hundred miles. (Note: this was probably more like 50 miles.) I could see that the formation was going to fly in front of me, as it was flying at approximately 170 degrees. I watched as these objects approached the snow border of Mt. Rainier, all the time thinking to myself that I was observing a whole formation of jets. In group count that I have used in counting cattle and game from the air, they numbered nine. They were flying diagonally in echelon formation with a larger gap in their echelon between the first four and last five. What startled me most at this point was the fact that I could not find any tails on them. I felt sure that, being jets, they had tails, but figured they must be camouflaged in some way so that my eyesight could not perceive them. I knew that the Air Force was very artful in the knowledge and use of camouflage. I observed the objects' outlines plainly as they flipped and flashed against the snow and also against the sky."

(L)"Anyhow, I discovered that this was where the reflection had come from, as two or three of them every few seconds would dip or change course slightly, just enough for the sun to strike them at an angle that reflected brightly on my plane."

(B)"Since this formation of craft was at almost right angles to me and was traveling north to south I was in an excellent position to clock their speed. I determined to make an attempt to do so. (L) I had two definite points I could clock them by. (Note: by this he means Mt. Rainier and Mt. Adams, about 47 miles to the south). The air was so clear that it was very easy to see the objects and determine their approximate shape and size at almost fifty miles that day. I remember distinctly that my sweep second hand on my eight day clock, which is located on the instrument panel, read one minute to 3 PM as the first object of this formation passed the southern edge of Mt. Rainier. "

"Now, clocking speeds by only your sweep second hand cannot be entirely accurate because several seconds could be lost in breaking your gaze to observer your clock. I recall that when the first craft of thie formation jettefd to the southward from the snow-based cleft of Mt. Rainier my second hand was approaching the top of my hour dial and the time was within a few seconds of one minute of three."

(L)"I watched these objects with great interest as I had never before observed airplanes flying so close to the mountain tops, flying directly south to southeast down the hog's back of a mountain range. I would estimate their elevation could have varied a thousand feet one way or the other up or down, but they were pretty much on the horizon to me which would indicate that they were near the same elevation as me. They flew like many times I have observed geese to fly in a rather diagonal chain-like line as if they were linked together. They seemed to hold a definite direction but rather swerved in and out of the high mountain peaks. I could quite accurately determine their pathway due to the fact that there were several high peaks a little this side of them as well as higher peaks on the other side of their pathway."

COMMENT: These statements about how they flew with respect to the mountain peaks are very important because they provide information on the distance from Mr. Arnold. These mountain peaks lie along a wide north-south line extending southward from Mt. Rainier to Mt. Adams. These peaks were about 20 miles east of Arnold at the time. These statements also provide the altitude of the objects. To Arnold they appeared to be approximately at his altitude because

they seemed to be "pretty much on the horizon to me." Since he was flying at 9,200 ft, this implies that they were close to that altitude. (Arnold actually stated his letter that they were at 9,500 ft.) However, the mountain peaks south of Rainier generally are 5,000 to 7,000 ft high, with the higher ones being farther away (more to the east) from Arnold. Hence his statement that there were higher peaks on the far side of the pathway indicates that the objects were definitely lower than about 7,000 ft. Furthermore, he stated that they went behind some (or at least one) of the lower, closer peaks. Geological survey maps show that mountain peaks which the objects could have disappeared behind have altitudes of 5,000 to 6,000 ft. Hence it appears that they were lower than 6,000 ft and that Arnold overestimated their altitude. (There has been an argument that the only peak high enough to block that path at 9,500 ft altitude is a peak jutting out from the southeast side of Mt. Rainier. In order for the objects to pass behind this peak they would have had to pass behind the main peak of Rainier. However, Arnold didn't indicate that they disappeared behind Rainier itself [see above and also a statement below. Instead, he clearly said he could see then silhouetted against the snow of Mt. Rainier. Hence Arnold's testimmony indicates that their path was west of Rainier.)

Is it reasonable to assume that he could have made an error of several thousand feet in estimating their altitude? The answer to this question lies in the fact that Arnold inferred the altitude by observing that the objects appeared to be almost exactly on his horizon (i.e., level with his altitude). But it is very difficult to determine the exact horizon from an airplane. In this case, the angle (the "depression angle") between exact horizontal and his downward sighting line to the mountain peaks south of Mt. Rainier was very small. The depression angle from Arnold's plane at 9,200 ft altitude to the top of a 5,500 ft high mountain at a distance of 20 miles (105,600 ft) was about 2 deg. Such a small angle would be difficult to detect from an airplane. So the answer is yes, he could easily have made an error of 4,000 ft in estimating the altitude of the objects. Perhaps if he had looked up the actual altitudes of the mountain peaks south of Mt Rainier he would have revised his statement. On the other hand, if the objects had been at 9,500 or so feet they would have been clearly above the tops of the mountains south of Mt. Rainier and one wonders why Arnold would have said that they appeared to "swerve(d) in and out of the high mountain peaks."

FORMATION AND “SKIPPING SAUCER” FLIGHT DYNAMICS

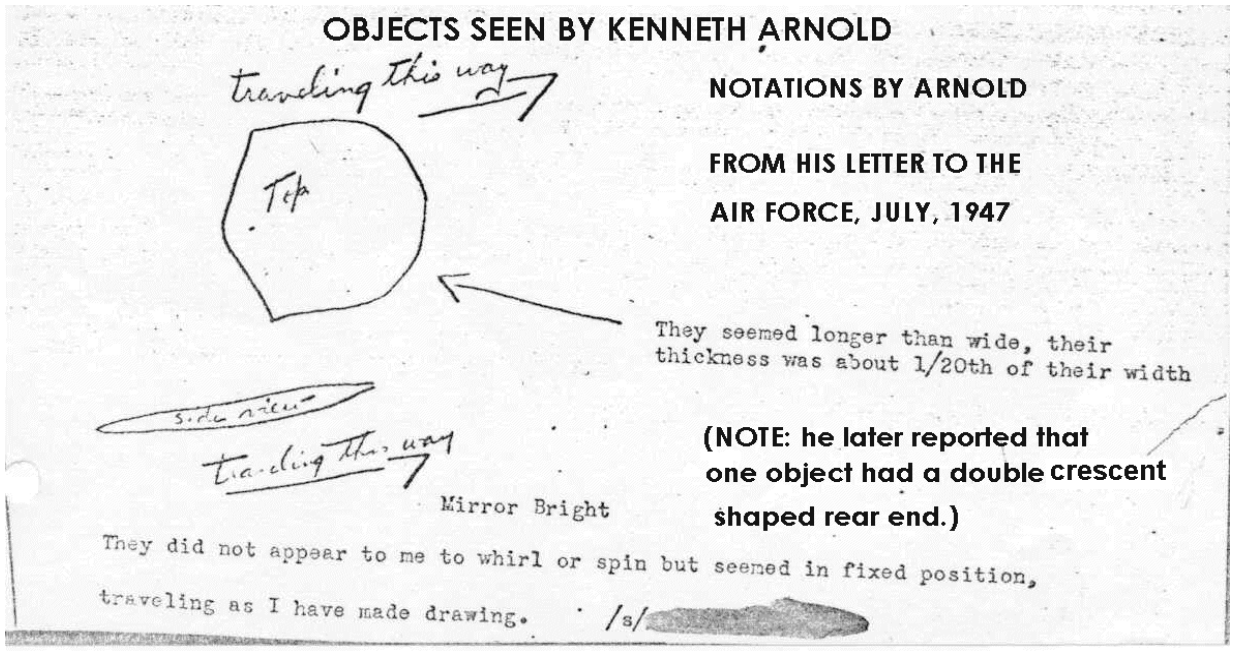
While Arnold was timing the flight he observed the objects carefully. According to his letter,

(L) "I observed these objects not only through the glass of my airplane but turned my airplane sideways where I could open my window and observe them with a completely unobstructed view. (Without sun glasses.)"

(B) "I was fascinated by this formation of aircraft. They didn't fly like any aircraft I had ever seen before. In the first place their echelon formation was backward from that practiced by our Air Force. The elevation of the first craft was greater than that of the last. They flew in a definite formation but erratically. As I described them at the time their flight was like speed boats on rough water or similar to the tail of a Chinese kite that I once saw blowing in the wind. Or maybe it would be best to describe their flight characteristics as very similar to a formation of geese, in a rather diagonal chain-like line, as if they were linked together. As I put it to newsmen in Pendleton, Oregon, they flew like a saucer would if you skipped it across the water."

"Another characteristic of these aircraft that made a tremendous impression on me was how they fluttered and sailed, tipping their wings alternately and emitting those very bright blue-white flashes from their surfaces. At the time I did not get the impression that the flashes were emitted by them, but rather that it was the sun's reflection from the extremely highly polished surface of their wings."

(L)"What kept bothering me as I watched them flip and flash in the sun right along their path was the fact that I couldn't make out any tail on them, and I am sure that any pilot would justify more than a second look at such a plane. The more I observed these objects the more upset I became, as I am accustomed and familiar with most all objects flying whether I am close to the ground or at higher altitude. Even though two minutes seems like a very short time to one on the ground, in the air in two minutes time a pilot can observe a great many things and anything within his sight of vision probably as many as fifty or sixty times. Of course, when the sun reflected from one or two or three of these units, they appeared to be completely round; but, I am making a drawing to the best of my ability, which I am including, as to the shape I observed these objects to be as they passed the snow covered ridges as well as Mt. Rainier.



(L)"When the objects were flying approximately straight and level, they were just a black thin line and when they flipped was the only time I could get a judgement as to their size. These objects were holding an almost constant elevation; they did not seem to be going up or coming down, such as would be the case of artillery shells. I am convinced in my own mind that they were some type of airplane, even though they didn't conform with the many aspects of the conventional types of planes I know."

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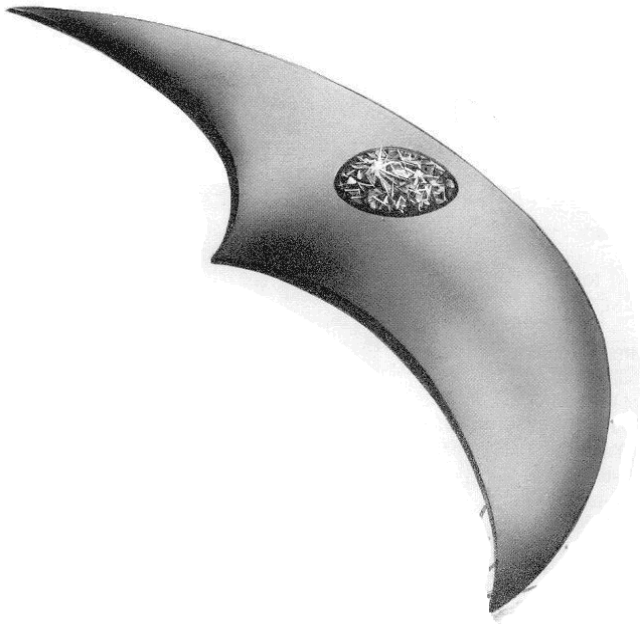
COMMENT: In his letter Arnold included a sketch which shows the leading edge being nearly a semicircle, with short parallel sides and with the rear being a wide angle convex (protruding) V shape that comes to a rounded point at the trailing edge. (See also his recorded description in the Appendix: half a pie pan with a convex triangle at the rear.) He wrote on the sketch that "they seemed longer than wide, their thickness was about 1/20th of their width." His suggestion that their width (or length) was about twenty times greater than their thickness may be an exaggeration. The sketch he drew of how they appeared "on edge" has the dimensions 4 mm wide by 45 mm long (approx.) which suggests a ratio closer to 1/11. Although he did not mention it in his letter, he later stated (e.g., in his book) that one of the objects had a somewhat different shape. His book shows an illustration in which the object has a semi-circular front edge and a rear edge that consists of two concave edges that join at a rearward pointing cusp at the center of the rear edge. See below.

THE APPROXIMATE SHAPE OF ONE OBJECT



THE ANGULAR SIZE AND SPEED OF THE OBJECTS

(L)"I knew they must be very large to observe their shape at that distance, even on as clear a day as it was that Tuesday. In fact I compared a zeus fastener or cowling tool I had in my pocket - holding it up on them and holding it up on the DC-4 - that I could observe at quite a distance to my left, and they seemed smaller than the DC-4; but I should judge their span would have been as wide as the furtherest engines on each side of the DC-4. "

(L)"I observed the chain of these objects passing another snow-covered ridge in between Mt. Rainier and Mt. Adams, and as the first one was passing the south crest of this ridge the last object was entering the northern crest of the ridge. As I was flying in the direction of this particular ridge, I measured it and found it to be approximately five miles so I could safely assume that the chain of these saucer like objects were at least five miles long.

(B)"Even though they held a constant direction they swerved in and out of the high mountain peaks which are found on the hogback of the Cascade mountains between Mount Rainier and Mount Adams. I determined my distance from their pathway to be in the vicinity of 23 miles because I knew where I was and they revealed their true position by disappearing from my sight momentarily behind a jagged peak that juts out from the base of Mt. Rainier proper. Considering that I was flying all this time in the direction of their formation, the determination can be only approximate, but it is not too far off."

"Between Mount Rainier and Mount Adams there is a very high plateau with quite definite north and south edges. Part of this chain-like formation traveled above this plateau toward Mount Adams, while part of the formation actually dipped below the near edge. As the first unit of these craft cleared the southernmost edge of this background, the last of the formation was just entering the northern edge. I later flew over this plateau in my plane and came to a close approxinmation that this whole formation of craft, whatever they were, formed a chain in the neighborhood of five miles long.

"As the last of this group of objects sped past and seemed to gather altitude at a point beyond the southernmost crest of Mount Adams, I glanced at the sweep second hand of my instrument clock. As closely as I could determine , this strange formation of aircraft had covered the distance between Mount Rainier and Mount Adams to the south in one minute and forty-two seconds."

(L)"As the last unit of this formation passed the southern most high snow covered crest of Mt. Adams, I looked at my sweep second hand and it showed that they traveled the distance in one minute and forty-two seconds. Even at the time this timing did not upset me as I felt confident after I would land there would be some explanation of what I saw. I might add that my complete observation of these objects, which I could even follow by their flashes as they passed Mt. Adams, was around two and one-half or three minutes--although, by the time they reached Mt. Adams they were out of my range of vision as far as determining shape or form. "

COMMENT: Arnold provided an estimate of size in an indirect way: he stated that they appeared

to be comparable to the spacing of the engines on a DC-4 (4 engine propellor driven, 117 ft wingspan, 94 ft length, 27 ft height) which he had seen at a distance which he estimated as 15 miles. He estimated the engine spacing to be 45 - 50 ft, although 60 ft would have been a better estimate. By this means he was essentially providing an angular size, measured front-to-back, for the objects: the equivalent of about 50 (or 60) ft at 15 miles. He reported the size of the objects as 45 - 50 ft by comparison with the airplane as if the plane had been at the same distance as the objects. However, the plane was not at the same distance, so a correction for the distance difference is necessary.

It is possible to make an estimate of the front-to-back size of the objects assuming his estimate of the distance to the DC-4, 15 miles, was (approximately) correct. Using the outer engine spacing as about 60 ft, the angular size at his estimated distance is 60/(15 x 5280) = 0.00076 radians or about 2.6 minutes of arc (1 degree = 60 minutes = 0.0174 radians). Projecting this angle to 20 miles, the rough distance of the objects, would yield a size of about (20 x 5280 x 0.00075 =) 80 ft. Had he overestimated the distance to the DC-4 (if it had been less than 15 miles away) the calculated angular size, and hence the calculated object size would increase. If he underestimated the distance to the DC-4, then the calculated size of the objects would decrease. My own suspicion is that he overestimated the distance and that therefore the objects were larger than 80 ft in length. Unfortunately no investigator pursued this size estimate at the time and with Arnold's death many years ago it is no longer possible to improve the size estimate.

Using the dashboard clock in his airplane Arnold measured the time from when the first object passed the side of Mt. Rainier until the last object passed Mt. Adams. The distance from the flank of Mt. Rainier to the peak of Mt. Adams is about 45 miles (depending upon where on the side one picks as the starting point). Since the length of the "chain" of objects was about 5 miles, the leading object was about 5 miles south of Mt. Adams when the last object passed Mt. Adams. Hence the total distance it (and the others) traveled was about 50 miles in 102 seconds. This corresponds to a speed of about 1,760 mph. (Arnold intentionally underestimated this speed, saying that it was 1,200 mph or more, which was still faster than any aircraft of the day. Chuck Yaeger was the first person to "break" the "sound barrier" at about 700 mph in October, 1947.)

Arnold estimated that he had the objects in view for a total of about 2.5 to 3 minutes. During that time, if their speed was constant, they may have traveled a total of 80 to 90 miles, starting from a location about 30 or 40 miles north of Mt. Rainier where Arnold first saw them (not from the 100 mile distance near Mt. Baker, as Arnold had thought) to some distance south of Mt. Adams, where they disappeared from view. According to Arnold (B) this strange formation of aircraft seemed to "gather altitude", i.e., rise upward, as they passed Mt. Adams. If true, then they were clearly not falling to the earth (see meteor explanation below).

After this sighting Arnold considered continuing the search for the downed C-46, but

(B)"somehow the $5,000 (reward) didn't seem important. I wanted to get on to Yakima and tell some of the boys (other pilots) what I had seen."

ARNOLD REPORTS HIS SIGHTING

When Arnold landed at Yakima, Washington, he told some of the people at the airport about these amazing high speed aircraft.

(L)"When I landed at Yakima, Washington airport I described what I had seen to my very good friend Al Baxter, who listened patiently and was very courteous but in a joking way didn't believe me."

COMMENT: He then flew to Pendleton, Oregon on a business trip. During that flight he did an initial calculation of the speed of the craft. He also recalled that one of the objects had (B)"looked different from the rest, was darker and of a slightly different shape." This was the craft with the double crescent rear end illustrated above. The discussion of his sighting presumably would have ended in Yakima if it hadn't been for the fact that someone at the airport contacted the press to report that some new, high speed aircraft had been sighted. When Arnold arrived at Pendelton he was surprised to find a number of reporters eager to learn about the new aircraft. Arnold told them about the sighting and his (under)estimated speed of 1,200 mph. He then described how they flew: they wobbled and flipped, like saucers skipping on the water.

(L)"I did not accurately measure the distance between these two mountains (Note: Rainier and Adams) until I landed at Pendleton, Oregon, that same day where I told a number of pilot

friends of mine what I had observed and they did not scoff or laugh but suggested they might be guided missiles or something new. In fact several former Army pilots informed me that they had been briefed before going into combat overseas that they might see objects of similar shape and design as I described and assured me that I wasn't dreaming or going crazy. .....A former Army Air Forces pilot ...(told me)..."What you observed, I am convinced, is some type of jet or rocket propelled ship that is in the process of being tested by our government or even it could possibly be by some foreign government."

COMMENT: The reporter, hearing the description, used the description of the way they flew, as saucers skipping across the water, and after several days the press condensed this into a name which we have been stuck with ever since: FLYING SAUCERS.

NOTE ON THE INITIAL PRESS INTEREST AND THE TERM FLYING SAUCER

In 1988 Pierre Lagrange, a sociologist who lives in France, interviewed Bill Bequette, one of the first reporters to interview Arnold. In 1947, Bequette was a 28 year-old journalist, working for the East Oregonian newspaper in Pendleton, Oregon in 1947. He wrote the first Associated Press dispatches and these news stories were the first indicators of the 1947 UFO sighting flap. Bequette said he first met Arnold the day after the sighting (i.e., June 25). Quoting from Lagrange's interview, "Both Nolan Skiff and I were in the office, which was small, when Mr. Arnold came in. As I remember, we both talked with him, listened to his story, told him we didn't have a clue to what he had seen but would send the story to the Associated Press in hopes some editor or newspaper reader might be able to explain the strange objects. That first meeting probably lasted no more than five minutes. Nolan jotted down a few notes, then wrote a short story, which I squeezed into the bottom of page one. Then I punched an even shorter (as I recall) version into the AP wire. We were only minutes from "putting the paper to bed" so we didn't have much time to give him. "

It is important to note Bequette's statment that the initial stories on the new wires were based on this very brief interview and the very brief description of the sightings. The brevity can explain why some important details did not make it into the initial published news stories and why there is some confusion on details in the initial stories. Of course, the press rarely gets stories 100% correct weven when including all details.

Later, there was a more extensive interview: "When I returned to the office after lunch, the receptionist's eyes were as big as saucers - the kind we use under coffee cups! She said newspapers from all around the country and Canada had been calling. They wanted more details on the "flying saucers." I spent the next two hours with Mr. Arnold in his hotel room. From that interview I wrote a story about 40 column inches long. The story was telephoned to the AP Bureau in Portland. Next morning, almost every newspaper in the country published the story on Page 1. even after 40 years I feel some embarrassment over the original UFO story. My embarrassment is because I failed to recognize what a big story Mr. Arnold brought into the office that day.

Bequette does not believe that he invented the term "flying saucer." He told Lagrange, "I don't remember whether or not Arnold used the words 'saucer-shaped craft.' I am inclined to credit his version (that he only spoke of objects moving like a saucer if you skipped it across the water), knowing the tendency of journalists to rephrase. I'm sure I didn't coin 'Flying Saucers.' "

Bequette also formed an opinion about Arnold: "Mr. Arnold did not impress me then as a person who 'saw things.' And Nolan Skiff also believed Mr. Arnold to be an honest and sincere person who was genuinely puzzled by what he had seen that day. Arnold was most cooperative when I went to his hotel room for a follow-up story. He seemed eager, as I remember, to answer all my questions as fully as possible. Arnold became the butt of many jokes, some of which were not good-natured, in the ensuing days and weeks. "

EXPLANATIONS OFFERED FOR KENNETH ARNOLD'S SIGHTING

The question now arises as whether or not Arnold's sighting could be explained as some known, natural or man-made phenomenon or if the sighting could not be explained. If it could not be explained then did Arnold's sighting prove there were unexplainable objects, possibly craft of non-human origin, flying around in our atmosphere? In order to answer these questions we must study potential explanations for the sighting, explanations based on known, if rare, phenomena that obey conventional science and physics in particular.

During the summer of 1947, shortly after Arnold's sighting and during the massive wave of sightings that occurred between late June and the middle of July, numerous explanations for the sightings of Arnold and other withnesses were proposed. The first explanation was that proposed

by Arnold himself, namely that saucers were some new secret aircraft of the United States Army Air Force (the Air Force was still part of the Army). However, very quickly (within days) after Arnold's sighting the U.S. government publicly denied having any secret aircraft that could account for saucer sightings. This denial was also privately made to J. Edgar Hoover, the Director of the Federal Bureau of Investigation (FBI) by General George Schulgen of the Army Air Force. (The denial is in the FBI's file on flying discs, the "real X file." See ref. 12.) On the other hand, the Air Force began to be worried over the possibility that the Soviet Union had developed flying saucers to threaten the United States, but this worry was not conveyed to the public. The Air Force also considered the possibility that saucer stories were generated by Soviet sympathizers to make the American people think that the Air Force could not control the skies over the USA.

Howard Blakeslee, the Associated Press Science Editor, wrote an article that suggested "quirks of eyesight" could explain the saucer mystery. He pointed out that anything looks round if it is too far away to see details. "This law covers small things seen nearby and large ones at great distances." He described his own sightings of "flying saucers" which were bright reflections from distant aircraft. "Planes at great distances tend to look round when light is reflected from their sides," he wrote. He rejected the daytime meteor hypothesis (see below) and the hypothesis that upper altitude ice crystals formed "little round clouds." According to Blakeslee, "Nothing published in science or atomic studies gives the slightest clue to flying saucers unless the objects are aircraft."

Although I cannot now cite the reference, it is this author's recollection that someone claimed that flying saucers were actually "motes in the eye" which are small particles such as blood cells which float in the fluid within each person's eyeball. Motes are only visible when they move to an area between the lens and the fovea; when they move out of this area they "disappear." These particles, when viewed against a bright sky, can appear to be dark objects far away and thus may be mistaken for large objects at a great distance. Of course, they move whenever the eye does and this can impart "unearthly speeds" to the apparently distant, large objects. (Note: one can be temporarily fooled by motes, but a simple test is to turn the eye and stare in another direction. If the "object" moves with the eye, then it was a mote.)

Dan Nelson, an attorney in Oklahoma City, published his explanation in the "Daily Oklahoman" newspaper, July 29, 1947. On July 30 the FBI contacted him to learn more about his solution to the mystery. (Yes, the FBI did investigate sightings in 1947, so, in a small sense the "X" files are real!) According to Nelson all sightings from inside vehicles, including airplanes, that had windows were reflections of sunlight from shiny objects onto the windows. The light reflected from these shiny objects was then re-reflected toward the eye of the observer who was looking through a window and could thus see the reflection silhouetted against the background as if there were a shiny object "out there", far outside the vehicle. Naturally reflections such as this could do unnatural things such as pace a vehicle or suddenly accelerate, make fast turns and even suddenly disappear. According to Nelson, the vibration of a car, for example, would give the objects "an appearance of rotating" and "reflections (in the windows) caused them to appear flat or saucer shaped." Moreover, "...any number of objects might be seen according to the direction that the car is traveling and the number of bright objects being reflected onto the window. He further stated that these objects might be seen in an ordinary window in a house according to the lighting conditions..." Mr. Nelson told the FBI that he had not actually talked to saucer witnesses but "he believed that these reflections plus the excitement and hysteria caused by other reports has been the basis for most flying saucer reports." (Classic armchair theorist!!) Obviously Nelson's explanation could not apply to Arnold's sighting, since Arnold viewed the objects through the open window, but Nelson didn't know that since Arnold's full report was not published until many years later.

Other explanations offered in the press for the numerous sightings reported in June and July, 1947, included just about anything that could be seen in the sky such as clouds, birds, kites, balloons, mirages and even "ice meteors." Several years later the Air Force settled on "mirage" as the explanation for Arnold's sighting. Having read the previous material you may wonder how the Air Force could justify that explanation. The answer is not straightforward.

The Air Force intelligence officers who investigated the initial saucer reports in the summer of 1947 and through the summer of 1948 treated all of the sightings, including Arnold's, seriously. This was, at least in part, a result of the fact that a number of Air Force pilots reported seeing flying saucers. Arnold's sighting was included as unexplained in the Top Secret intelligence memorandum compiled by Air Force intelligence at the Pentagon during the late fall of 1948 (ref. 3). However, in the early fall of 1948 General Hoyt Vandenburg rejected the conclusion, expressed by Air Force analysts in the "Estimate of the Situation," that saucers were interplanetary vehicles (See ref. 4). The analysts, who were the acknowledged experts in analysis of foreign aerodynamic vehicles, then visited the general to argue their case, but he told them something like this: "Sorry, wrong answer!" By rejecting the Estimate, Vandenburg effectively established an Air Force policy that the “interplanetary hypothesis” was not to be considered as an acceptable explanation for any sighting. Another alternative, that the Russians had made immense improvements on German aircraft developed during WWII and were flying their new aircraft over the United States, was too much for the intelligence analysts to accept. Therefore they were forced to come up with some conventional explanation for each sighting even if there was no logical conventional explanation. The "urge to explain" biased the sighting analyses done during Projects Sign (1948-1949) Grudge (1949-1951) and Blue Book (1951 - 1969). This sorry situation is described more fully, with numerous examples, in ref. 12.

[NOTE: Captain Edward Ruppelt, who was the director of Project Blue Book from late 1951 to early 1953, wrote that the Estimate was written by expert technical intelligence analysts at

Wright Patterson AFB who had concluded, in August, 1948, that "interplanetary" was the only logical explanation. They wrote the Estimate of the Situation and sometime in September sent it to General Hoyt Vandenburg Chief of Staff of the Air Force. He rejected the conclusion.]

During the early years of UFO sightings, explanations for Arnold's sighting were proposed by two scientists with close connections to the Air Force project. These skeptical scientists were Dr. J. Allen Hynek and Dr. Donald Menzel. Dr. Hynek, a professor at Ohio State University and then at Northwestern University, was the astronomy consultant to the Air Force's UFO projects starting with Project Sign in 1948 and continuing through the end of Project Blue Book in 1969. Although his specialty was astronomy he was asked to suggest explanations for all types of sightings. Dr. Menzel was an astrophysicist and director of the Harvard Observatory during the same time period. Dr. Hynek, who died in 1986, reversed his skeptical stance toward UFO reports in the late 1960's and, in 1973, founded the Center for UFO Studies, headquartered in Chicago, Illinois. Dr. Menzel, who died in 1976, never retreated from his published opinion that all sightings by credible observers could be explained, many as meteorological phenomena.

In 1948 Dr. Hynek (who was not aware of the Top Secret Air Intelligence Report (ref. 3)) was hired to analyze sightings and to decide which ones could be catagorized as misidentified astronomical phenomena. As a "side benefit" to the Air Force he also gave his opinion on the other sightings, including Arnold's. (ref. 9)

Hynek began his analysis of the sighting by assuming that at least part of what Arnold said was true: that Arnold could see the overall shape of the objects, that he could see them edge-on, and that he thought their width was about twenty times greater than their thickness. Hynek decided to try to calculate their size based on the basic visual capabilities of the human eye. He pointed out that the angular resolution of the human eye is typically about 3 minutes of arc (1 minute of arc = 1/60 of a degree = 0.00029 radians = 0.29 mr, where mr is the abbreviation for milliradians; the angular size of the moon is about 1/2 degree or about 30 minutes of arc or about 8.7 mr). He then claimed that if the vertical angular size, i.e., the apparent thickness, were substantially less than this, Arnold could not have seen the objects. Hence, Hynek concluded that the thickness must have been at least 3 minutes of arc (about one tenth of the apparent size of the moon). Hynek calculated that this angular size corresponds to a thickness of about 100 feet at the greatest distance estimated by Arnold, 25 miles. Therefore, if Arnold's 20:1 ratio of length to thickness were correct, then the objects were about about 2,000 ft long. Dr. Hynek could not accept the idea that 2,000 ft long objects were flying at high speed through the earth's atmosphere. It was just too ridiculously large.

But, on the other hand, Arnold had not said that the objects were that large. He had estimated that the objects were the size of fighter aircraft with typical lengths of 40 to 50 ft. One may imagine Hynek saying to himself, “Aha, a contradiction! There must be an error in Arnold’s estimates.” Hynek calculated that if, indeed, they had been this short then they would have been too small for Arnold to see any details. Furthermore, if the 20:1 ratio were correct, they would have been too thin to see edge-on if 25 miles away. Thus Hynek noted an inconsistency in Arnold's report: if the objects' size and distance were as estimated by Arnold he could not have seen any details of their shape because he could not have been seen them at all!

Hynek decided to resolve the inconsistency by ignoring both Arnold's distance and size estimates. Instead, Hynek argued that if the objects were a more reasonable size, say, the size of the largest known aircraft, roughly 400 ft long and 30 feet high, then they must have been much closer to Arnold in order for them to be seen "edge on." Hynek estimated their distance at 6 miles. At this distance the aircraft could appear (from the position of Arnold's plane) to travel past Mt. Rainier and then past Mt. Adams in 102 seconds if their speed were only about 400 mph. Hynek concluded as follows: "in view of the above (calculations) it appears probable" that Arnold saw "some sort of known aircraft."

As a result of Hynek's discussion of the discrepancy between Arnold's estimates of the distance and size of the objects, the Air Force officers who wrote the final report of Project Grudge in the spring of 1949 decided that "the entire report of this incident is replete with inconsistencies and cannot bear even superficial examination." (ref. 9)

So, what about Hynek's argument that the objects would have been too thin to be visible, based on his claim that the human eye can't see something smaller than 3 arc minutes in angular size? Does it make any sense at all? The answer to this question is no, and it comes in two parts. First, the fact is that many people can "see" objects smaller than 3 arc minutes in angular size, especially if they are larger than this in one dimension (e.g., like a long cylinder, such as a long wire, viewed from the side). The second part of the answer comes directly from Arnold's report to the Air Force. Although it would have been "nice" if Arnold could have taken an eye test to provide Hynek with actual visual acuity data, the fact is that some information in his report, information that Hynek ignored, provides us with a clue as to Arnold's visual acuity. He said he was able to see a DC-4 at 15 miles (estimated distance) and he compared the spacing of the engines on the plane with the apparent size of the saucers. With its visible height of about 23 ft, the vertical angular size of the DC-4 at that distance was about 0.00034 radians or about 1 arc minute. (Even if Arnold overestimated the distance and it was really 10 miles away then the vertical angular size would still have been less then 2 arc minutes.) Hence, by Hynek's criterion, Arnold should not have been able to see the DC-4, and certainly he wouldn't have been able to see the engines and thereby to see the spacing of the engines. But Arnold said that he did see the airplane and its engines and Hynek did not dispute that statement. Therefore Hynek's objection...the "inconsistency"... must be rejected.

Had Dr. Hynek tested his hypothetical explanation - "known aircraft" - against the information in Arnold's report he might have rejected his own explanation. To test Hynek's explanation assume that the unknown objects were ordinary large aircraft six miles away and ask the following question: why wasn't Arnold able to identify them, to see their engines, tails, wings, etc., even though Arnold was able to identify another aircraft that was about 15 miles away? Evidently Hynek did not notice the inconsistency in his own analysis. Had Hynek done what skeptics usually fail to do, that is, to thoroughly test his suggested explanation against the data, he would have seen that his hypothetical solution failed.

It is amusing to imagine what would have happened if Hynek had accepted Arnold's distance estimate. Then he would have been forced to accept the high velocity (about 1,700 mph), in which case it is conceivable that the early history of the UFO subject would be different from what actually occurred. But instead, Hynek, for good scientific reasons, I presume, chose to take the road more traveled by...to reject important parts of Arnold's sighting...and that has made all the difference (with apologies to poet Robert Frost!). The handwriting was on the wall, but Hynek erased it.

Dr. Hynek's work was done secretly for the Air Force and his discussion of Arnold's sighting was not published, although his conclusion was mentioned in the "Project Saucer" report published by the Air Materiel Command at Wright Field (now Wright-Patterson Air Force Base) on April 27, 1949. Few civilian scientists had access to Air Force files and so there was no dispute of Hynek's analysis until Dr. Donald Menzel decided to write about Arnold's sighting in his first book on UFOs, which was published in 1953 (ref. 5). This was the first flying saucer book by a scientist and, because of his stature in the field of astrophysics, it was treated very seriously. It received favorable reviews, although there were some atmospheric scientists who questioned Menzel's use of weather phenomena to explain sightings. Libraries and scientific organizations throughout the United States and in other countries ordered the book and it became an important reference for scientists in the following years. In retrospect this is unfortunate since, as I will demonstrate, Menzel did not provide accurate descriptions of some sightings and he apparently slanted the data as necessary to make his explanations fit, beginning with Arnold's sighting.

Menzel criticized the Air Force for accepting Hynek's suggestion that Arnold had seen rather close aircraft. He gave a brief description of Arnold's sighting and mentioned Arnold's estimate of distance and total sighting duration (3 minutes). Menzel wrote, "He clocked the speed at about 1,200 miles an hour, although this figure seems inconsistent with the length of time that he estimated them to be in view. From his previous statement they could scarcely have traveled more than 25 miles during the three minutes that he watched. This gives about 500 miles an hour, which is still a figure large enough to be startling.." Menzel did not tell the reader that Arnold had timed the flight of the objects between two points. Instead, Menzel invented a travel distance of 25 miles, and implied that this distance was covered in 3 minutes (180 seconds). Hence he was able to assign a much lower, although "startling," speed of 500 mph.

Menzel went on to "solve" the mystery of Arnold's sighting: "Although what Arnold saw has remained a mystery until this day, I simply cannot understand why the simplest and most obvious explanation of all has been overlooked.... the association of the saucers with the hogback (of the mountain range south of Mt. Rainier).... serves to fix their distance and approximate size and roughly confirms Arnold's estimate of the speed." (Note that Menzel, unlike Hynek, accepted Arnold's distance estimate). Menzel then went on to suggest that Arnold saw "billowing blasts of snow, ballooning up from the tops of the ridges" caused by highly turbulent air along the mountain range. According to Menzel, "These rapidly shifting, tilting clouds of snow would reflect the sun like a mirror...and the rocking surfaces would make the chain sweep along something like a wave, with only a momentary reflection from crest to crest."

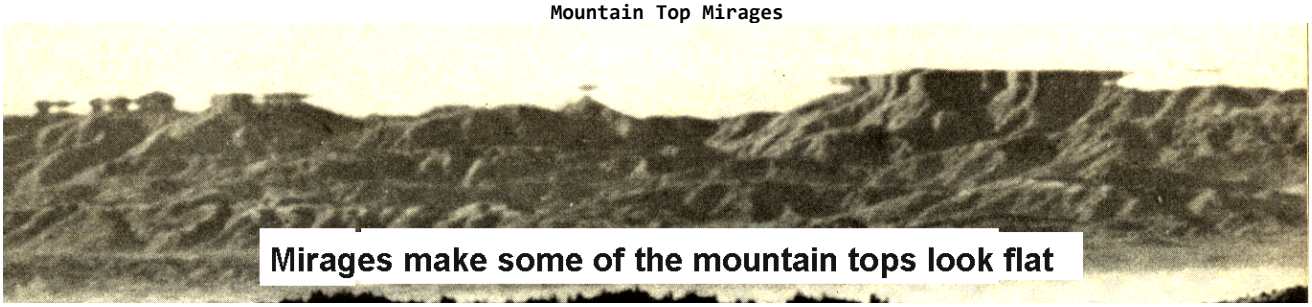
This first explanation by a scientist with the reputation of Dr. Menzel may seem slightly convincing, but only until one realizes that (a) snow cannot reflect light rays from the sun (60 deg elevation angle) into a horizontal direction toward Arnold's airplane and thereby create the very bright flashes that Arnold reported in the same way that a polished metal surface or mirror would, (b) there are no 1,200 mph or even 500 mph winds on the surface of the earth to transport clouds of snow (fortunately!), (c) there are no winds that would carry clouds of snow all the way from Mt. Rainier to Mt. Adams (Arnold saw the objects pass Mt. Adams before they were lost to his view), (d) Arnold had traveled westward past the southern flank of Mt. Rainier minutes before his sighting and then after the sighting he flew eastward past the southern flank; surely his plane would have been strongly buffeted (and perhaps destroyed!) by such high winds, but he reported, instead, very calm conditions. Furthermore, even if such amazing atmospheric phenomena had occurred, it is difficult to imagine how Arnold could have failed to realize that he was just seeing snow blowing from the mountain tops, especially since he flew over the mountains about 12 miles south of Mt. Rainier on his way east just a few minutes after the sighting.

In case the first explanation wasn't sufficiently convincing, Menzel offered "another possibility:" he suggested that perhaps there was a thin layer of fog, haze or dust just above or just below Arnold's altitude which was caused to move violently by air circulation and which reflected the sunlight. Menzel claimed that such layers can "reflect the sun in almost mirror fashion." Menzel offered no substantiation for this claim. Perhaps he was thinking in terms of a "reflection" from an atmospheric layer when the sun is so low on the horizon that the light rays make a "grazing angle" with the layer. If so, then that explanation as applied to the Arnold sighting makes no sense since the sun was at an elevation of 60 degrees and southwest of Arnold. An atmospheric oscillation wave can't bend or reflect light over an angle of nearly 60

degrees, which would be necessary to make it appear as if the sun had been reflected by objects nearly at Arnold's altitude. Moreover, an atmospheric oscillation wave with a "phase velocity" of 1,200 mph is unlikely, but in any case, when traveling southward its crests would be oriented east-west, so if it reflected any sunlight at all (highly unlikely), the reflection would be in the north-south direction and not westward toward Arnold's plane. Furthermore, layers form under stable conditions and violent air circulation would tend to break them up so there would be no "reflections" of sunlight. Again, one wonders how Arnold could have failed to notice that he was just seeing the effects of a haze layer.

Ten years after his first book, Dr. Menzel offered his third, fourth and fifth explanations in his second book (ref. 6, written with Lyle Boyd): mountain top mirages, "orographic clouds" and "wave clouds in motion". To support the third explanation he presented a photograph of mountain top mirages taken by a photographer many years earlier, and proposed by the photographer, as the explanation for Arnold's sighting. (This is the explanation which appears in the files of Project Blue Book, the "official" Air Force explanation. These files are can be viewed on microfilm at the National Archives in College Park, Maryland.) The mirages appear as vague images above the tops of the mountains. (Actually the mirage is an inverted image of the top of the mountain.)

Mountain Top Mirages



These mirages can be seen under proper atmospheric conditions (requiring a stable atmosphere) when the line of sight from the observer to the mountain top is tilted by no more than one half of a degree above or below horizontal. Unintentionally (or intentionally?) Menzel failed to report in his book the following information in Arnold's report: as they traveled southward he saw them silhouetted against the side of Mt. Rainier which is 14,400 ft high, much higher than the altitude of the saucers. Since mountain top mirages occur above the mountain peaks these objects were far below any mirage of Mt. Rainier. Of course, mountain top mirages stay above the tops of the mountains, so the mirage theory cannot explain the lateral high speed movement of the objects reported by Arnold. Nor can a mirage explain the brght flashes of light from the objects.

Menzel's fourth explanation was that Arnold saw orographic clouds which can assume circular shapes and often form in the lees (i.e., downwind of) mountain peaks. The clouds would, of course, be large but, as Menzel notes in his book, they "appear to stand more or less motionless." The lack of motion, as well as the lack of bright reflections, rules them out so, why did he even mention them? Also, Arnold would have realized they were just clouds as he flew past Mt. Rainier only minutes later.

Menzel's fifth explanation, wave clouds, is comparable to his first suggestion of "billowing blasts" of snow except that this time he proposed clouds of water vapor instead of snow. In his second book this explanation was supported by a photograph of such a cloud taken by a newspaper photographer. However, this explanation, too, fails to account for the very bright reflections reported by Arnold, for distinct semi-circular shapes and for the high lateral speed. Again, Arnold surely would have recognized a cloud as he flew past Mt. Rainier.

In his third and last UFO book (ref. 7; written with Dr. Ernst Taves in the early 1970's, just before Menzel died), which is subtitled "The Definitive Explanation of the UFO Phenomenon," Menzel again discussed Arnold's sighting and offered his sixth (and last) explanation: Arnold saw water drops on the window of his aircraft.

To support this explanation Menzel described a sighting of his own that turned out to be water drops that had condensed on the outside of the window of an aircraft in which he was flying. They moved slowly backwards from the front of the window. They were so close to his eyes as he looked out the window that they were out of focus and he thought they were distant objects moving at a great speed until, after a few seconds, he refocused his eyes and discovered what they were. In comparing his "sighting" with Arnold's, Menzel writes: "I cannot, of course, say definitely that what Arnold saw were merely raindrops on the window of this plane. He would doubtless insist that there was no rain at the altitude at which he was flying. But many queer things happen at different levels in the earth's atmosphere."

Although no one would argue with Menzel's claim that "queer things" happen at different levels of the atmosphere, this fact is irrelevant. Had Menzel bothered to carefully read Arnold's letter to the Air Force he would have seen Arnold's statement that he turned his plane sideways and viewed the objects through an open window to be sure that he was getting no reflections from window glass. (Fortunately Menzel did not propose water drops on Arnold's eyes!)

The “bottom line” is that neither Hynek nor Menzel proposed reasonable explanations for Arnold’s sighting, but that didn't stop the Air Force from accepting one of them (mirage).

In recent years further explanations have been proposed, most notably meteors and geese or pelicans.

In June, 1997, just in time for the 50th anniversary of Arnold's sighting, San Francisco Examiner writer Keay Davidson published the meteor explanation. The details of the explanation are given in a small monthly publication by Philip Klass which he calls the Skeptics UFO Newsletter (SKUFON; issue #46 of July 1997). (One wonders why it took 50 years for this explanation to be proposed. Could it be that previous skeptics considered this to be just too "outrageous?") Mr. Klass has been writing articles and books purporting to explain UFO sightings for at least the last 30 years, yet he has not previously "explained" the Arnold sighting. (His first book, UFOS IDENTIFIED was published in 1968.)

According to Mr. Klass writing in SKUFON the new explanation was published by Mr. Davidson after some research that was "sparked by a conversation" with Mr. Klass. The exact nature of this conversation was not reported, but one may imagine Klass suggested that Davidson ought to check on the possibility that Arnold saw meteors. According to Klass, after some research Davidson discovered that "the number of meteor falls reaches a peak around 3:00 PM," in June in the northern hemisphere. Arnold's sighting occurred at 3:00 PM, June 24, 1947. Thus, according to Klass' article, the large number of meteors detected in June lends support to the meteor hypothesis. (The astute reader will note the careful, "lawyerly" use of words: "lends support to" which is not the same as "proves" or "is evidence for.")

Klass' SKUFON article mentions Arnold's statement that the objects seemed bright and shiny as if reflecting the sun. By way of comparison and explanation Klass cites the 6:00 PM, June, 5, 1969 pilot sighting, which he claims turned out to be several meteors, in order to point out that meteors, when seen in the daytime, can look as if they are shiny metal. These pilots saw the bright objects seeming to come toward them (i.e., they were looking along the trajectory of the objects) and thought they were looking at shiny metallic objects. The pilots thought the objects were close, when in fact they were over a hundred miles away.

Klass also pointed out that pilots can make errors (as if we didn't know that!). The implication is that if the 1969 pilots could mistake daytime meteors for UFOS, then perhaps Arnold did, also. However, the Arnold sighting was quite different from the 1969 sighting.

Arnold reported seeing repeated bright flashes at varying time intervals from nine objects traveling one after another, along a roughly horizontal trajectory. Their altitude was considerably lower than the top of Mt. Rainier, i.e. well under 14,000 ft (they were probably about at 6,000 ft since they went "in and out" of mountain peaks south of Rainier). He realized that the flashes occurred as the objects tilted steeply to the left and right as they flew along a southward path. Arnold concluded that the flashes were a result of reflections of light from the sun which was high in the sky to the west (behind him). The objects flew southward past Mt. Rainier and, when they weren't tilted, he saw them as thin dark lines silhouetted against the snow on the sides of Mt. Rainier. When they were tilted but not aligned with the sun so as to make a bright flash, he saw them as semi-circular at the front with convex, somewhat pointed rear ends (one seemed to have a double concave crescent shape at the rear).

By way of contrast, meteors which are traveling fast enough to appear to glow do not dim to the point of being "not bright" and then brighten again. This is because, as Klass correctly points out, what causes the light is the high velocity of the meteor passing through atmosphere. The meteor is traveling so fast that it "instantaneously" heats the air as it passes through. (Note: Klass gives a meteor speed as 10,000 mph or 2.8 mi/sec. However, this is lower than that of any body entering the earths atmosphere from space. Free fall to the earth from a great distance would produce a speed of about 7.4 mi/sec at the earth's surface in the absence of atmosphere. Orbital speed, which is lower than meteoric speed but still large enough to cause a plasma in the upper atmosphere, is about 5 mi/sec.) This heating is a very rapid process caused by the meteor compressing the air ahead of it and raising the temperature (kinetic energy of the air molecules) to the point where the air becomes ionized (a plasma). In returning to the un-ionized state (free electrons reuniting with the atoms/molecules) the atoms/molecules give off light which appears to envelop the meteor (one does not see the meteor itself, but rather the envelope of heated air). The natural tendency of a meteor is to slow down as it meets with resistance while forcing itself at high speed through the atmosphere. If it slows to a speed low enough so that it no longer creates a plasma it will become dark (not giving off light) and will not again appear bright since there is no way for it to regain its lost speed. At the high altitudes of meteors (50 miles and up) the atmosphere is quite thin and easily heated to the plasma state by the speed of the meteor. Furthermore the air resistance is quite low, so the meteor can travel a great distance before being slowed to "sub-plasma" speed. However, as the altitude decreases the atmospheric density increases and it takes ever more energy from the meteor to maintain a glowing plasma. It is doubtful that any meteor would be still glowing at an altitude of 10,000 ft, but if it were, it would be quite large and eventually slowed to the point of hitting the earth. The suggestion that one.. or several... meteors could travel many miles horizontally at a speed high enough to glow while at an altitude below 10,000 ft is not supported by any known physics of meteors.

Klass points out that Arnold estimated he saw the objects for 2 1/2 to 3 minutes. This included about 1/2 minute of time before they passed Mt. Rainier and another nearly 2 minutes

after they passed Rainier. This would be "extra long" for a meteor (most burn out in a second or so; large meteors called fireballs can last many seconds). Hence Klass argues that Arnold's time estimate was probably wrong. He points out that "witnesses are notoriously unreliable in estimating the time duration of unexpected events" and cites the Mar. 3, 1968 reentry of the Zond Soviet space rocket as an example in which witness errors resulted in sighting duration estimates as low as 15 seconds and as high as 5 minutes.

There is an important difference between Klass' example of witness error and the Arnold sighting: Arnold used a clock!

Klass acknowledges that Arnold used his dashboard clock to time the passage of the objects between Mt. Rainier and Mt. Adams but Klass does not mention the time duration reported by Arnold. Instead, he writes as follows: "SUN questions whether Arnold...who was focusing his attention on the unusual obejcts while also occupied flying his aircraft... would have taken his eyes off the objects to carefully observe his cockpit clock." In other words, Klass questions the accuracy of the witness' claims about his own actions. If the actions seem illogical to Klass, then the actions are suspect and, of course, any data resulting from the actions are suspect.

So, why did Arnold do such an "illogical" thing as look at his dashboard clock as the objects were disappearing? Even though Klass used Arnold's letter to the Air Force as a reference, he does not tell his readers that Arnold wrote that he intentionally measured the speed: "I had two definite points I could clock them by" (he was referring to Mt. Rainier and Mt. Adams). He reported that he could see the objects were flying southward so he looked at his dashboard clock as the first object passed the south flank of Mt. Rainier. He then watched the objects as they continued southward. During this time the objects passed over a ridge that is about 5 miles long. According to Arnold "the first one was passing the south crest of the ridge" as the last one "was entering the northern crest." Hence they covered a total distance of about 5 miles. By the time they were passing Mt. Adams they were so far away he could only see their flashes. At this point there was <u>no reason to continue watching carefully</u> because they were fading out in the distance. Therefore he wasn't missing anything by taking his eyes off the objects to look at the clock. The second hand on his clock showed that 102 seconds had passed. (Note: he was able to pay attention to the objects even though flying the plane because, as he reported, the atmosphere was calm and clear and there were no aircraft in his vicinity; the closest aircraft was roughly 15 miles north and heading away from him.)

The calculated speed based on Arnold's measured time between Rainier and Adams is by itself sufficient to reject the meteor explanation (is this why Klass did not report the calculated speed?). The objects traveled about 50 miles in 102 seconds, corresponding to a speed of about 1,700 mph, far below any meteoric speed and certainly not enough to make the atmosphere glow.

By way of comparison, if one were to hypothesize a meteor in a level trajectory traveling at essentially orbital speed but at an altitude below 14,000 ft, it would have required roughly 9 - 10 seconds to travel from Mt. Rainier to Mt. Adams. Even at Klass' underestimated speed of 10,000 mph the flight time between the peaks would be only about 17 seconds. One would hope that Arnold, using his dashboard clock, could tell the difference between 102 seconds and 10 (or 17) seconds.

Aside from the difficulty in imagining that Arnold could mistake 10 seconds for 102 seconds, the mere suggestion that a meteor, or nine such meteors, could travel at a meteoric speed at an altitude of 6,000 ft while glowing brightly is far outside the accepted meteor phenomenology. As pointed out above, meteors cool as they penetrate the lower atmosphere, or rather the speed decreases to the point that they are no longer ionizing the dense air. Hence the basic concept that Arnold saw bright meteors traveling past Mt. Rainier must be rejected.

More recently (1998-2000) some skeptics have proposed that Arnold saw a flight of white geese or white pelicans heading southward at high altitude (about 9,000 ft). These birds were proposed because they can fly quite rapidly, perhaps up to 50 miles per hour, they fly one after another (often in a V shaped pattern), they "flutter" when they fly, and their white feathers can appear bright against the sky (just how bright is never defined). Of course they would have had to have been quite close to Arnold for him to see them (80 ft objects at 20 miles subtend the same angle as 4 ft long objects at 1 mile; this size refers to the length of the bodies of the birds; the wings would have been seen nearly edge-on and so, although the wingspan might be as much as 12 ft, this size would not have been seen broadside, but in a foreshortened perspective). According to the skeptics there are many reasons to prefer the pelican explanation over the "otherworld craft" (TRUFO) explanation. For some skeptics the choice of pelicans is to be preferred even if that explanation makes no sense in the context of the sighting.

Of course, these birds would not cause bright mirror-like reflections of the sun but the skeptics ignored that "minor" detail or tried to imagine that Arnold incorrectly reported the bright "flashing" of these objects (perhaps assuming that Arnold got it wrong or simply lied about it). (Note: the relative brightnesses of snow, birds and shiny, metallic reflectors are discussed in Appendix 2.) They also ignored Arnold's claim that he turned his plane, rolled down his window (to view them without glass in the way) and flew parallel to the flight path of the objects for a short time. Because of the type of aircraft he was flying his speed would definitely have been above a stall speed of 80 mph (Arnold said he was traveling over 100 mph air speed). By drawing a map, using a reasonable assumption about Arnold's flight path and and a reasonable assumption about the path of hypothetical pelicans or geese, one can show that the

birds would never appear to pass Mt. Rainier and then, 100 or so seconds later, appear to pass Mt. Adams, from Arnold's (moving) perspective.

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surely the Arnold sighting has been explained?

NOT!

THE PROSPECTOR'S SIGHTING

In the weeks following Arnold's sighting there were over a thousand sighting (based on the most recent reviews of the newspapers throughout the USA). One of these was directly related to the Arnold sighting. (There was also a second hand report that a forest service employee in a fire watchtower saw strange object fly past the Rainier area on the same day as Arnold's sighting but this witness never came forward so this remains an uninvestigated report.)

A second witness claimed that he saw the same objects as Arnold. His sighting occurred just as Arnold was losing sight of them near Mt. Adams. (Dr. Hynek evidently was not aware of this because he indicated in his analysis of the Arnold sighting that there were no other witnesses.) This witness did not report his sighting to the press, but rather directly to the Air Force.

In the latter half of August the Air Force received an unsolicited letter dated August 20, 1947, which reads as follows (the errors in the original letter are preserved; emphasis added):

****

Sir. Saw in the portland paper a short time ago in regards to an article in regards to the so called flying disc having any basis in fact. I can say am a prospector and was in the Mt Adams district on June 24th the day Kenneth Arnold of Boise Idaho claims he saw a formation of flying disc. And i saw the same flying objects at about the same time. Having a telescope with me at the time i can asure you they are real and noting like them I ever saw before they did not pass verry high over where I was standing at the the time. plobly 1000 ft. they were Round about 30 foot in dimater tapering sharply to a point in the head and in an oval shape. with a bright top surface. I did not hear any noise as you would from a plane. But there was an object in the tail end looked like a big hand of a clock shifting from side to side like a big magenet. There speed as far as i know seemed to be greater than anything I ever saw. Last view I got of the objects they were standing on edge Banking in a Cloud.

Yours Respectfully
(Fred Johnson)

****

(Note: the Blue Book file page which contains this letter is labelled "A TRUE COPY" that was authenticated by Lt. Col. Donald Springer. I assume that the errors in the above letter were in the original letter and were not simply errors in copying.)

At this time during the summer of 1947 the FBI was actively investigating sightings, at the request of the Army Air Force, to determine whether or not any such reports could be part of subversive activities carried on by enemies of the United States. (The FBI ended these investigations, having found no evidence of subversion, in the fall of 1947.) Therefore, at the request of the Air Force, an FBI agent interviewed Mr. Johnson. He sent a copy of his report to FBI headquarters in Washington, DC, with the title "REPORTS OF FLYING DISCS, SECURITY MATTER - X." (This report was discovered when the FBI responded to a Freedom of Information Act request which I made in 1976 for any documents concerning flying saucers, UFOs, etc. The FBI found well over 1,000 pages of material relating to the Air Force investigation of UFOs, internal memoranda and sightings reported to the FBI. See ref. 12.). The FBI report on Johnson's sighting reads as follows:

(Fred Johnson, resident of) First Avenue, Portland (Oregon), reported without consulting any records that on June 24, 1947, while prospecting at a point in the Cascade Mountains approximately five thousand feet from sea level, during the afternoon he noticed a reflection, looked up, and saw a disc proceeding in a southeasterly direction. Immediately upon sighting this object he placed his telescope to his eye and observed the disc for approximately forty-five to sixty seconds. He remarked that it is possible for him to pick up an object at a distance of ten miles with his telescope. At the time the disc was sighted by Johnson it was banking in the sun, and he observed five or six similar objects but only concentrated on one. He related that they did not fly in any particular formation and that he would estimate their height to be about one thousand feet from where he was standing. He said the object was about thirty feet in diameter and appeared to have a tail. It made no noise.

According to Johnson he remained in the vicinity of the Cascades for several days and then returned to Portland and noted an article in the local paper which stated in effect that a man in Boise, Idaho, had sighted a similar object but that authorities had disclaimed any knowledge of such an object. He said he communicated with the Army for the sole purpose of attempting to add credence to the story furnished by the man in Boise.

Johnson also related that on the occasion of his sighting the objects on June 24, 1947 he had in his possession a combination compass and watch. He noted particularly that immediately before he sighted the disc the compass acted very peculiar, the hand waving from one side to the other, but that this condition corrected itself immediately after the discs had passed out of sight.

Informant appeared to be a very reliable individual who advised that he had been a prospector in the states of Montana, Washington and Oregon for the past forty years.

Mr. Johnson's letter to the Air Force indicates that he was in the right area at the right time to see the objects which Arnold reported. Johnson, like Arnold, reported that his attention was attracted to them by a reflection, possibly a flash of light on the rocks he was examining. He reported only five or six, but it is likely that he missed seeing the others as he concentrated on his telescopic view of a single one. (Also, he was recalling the event almost two months after it occurred, so he may well have forgotten some details, such as the exact number of objects.) He thought they were only about 1,000 ft above his altitude of about 5,000 ft. Adding his estimated distance of the objects above him, 1,000 ft, to his estimated altitude, 5,000 ft, yields an altitude for the UFOs, about 6,000 ft, which is consistent with the altitude indicated by Arnold's claim that they were traveling "in and out" of the mountain peaks south of Mt. Rainier. On the other hand, Arnold also said that, from his point of view, the objects seemed to be climbing as they passed Mt. Adams. He thought that they might even have been a bit higher than Mt. Adams which is about 12,000 ft high.

Johnson claimed that he watched one disc for 45 to 60 seconds. Assuming that they were traveling at the speed calculated previously, about 1,700 mph, in 45 seconds they would travel about 20 miles. Although it may have been possible that Johnson could see the objects over a distance of 20 miles from his location, it seems more likely that he saw them for less time. However, even if it were only for 30 seconds with his telescope, we may assume that he was able to discern many details that Arnold couldn't see, such as the point on the front and the "tail" waving side to side "like a big magenet" in the rear. (Here I presume Johnson is comparing it with the magnetic needle in a compass which swings left and right before reaching equilibrium.) He claimed that the objects were "round" and also "oval," thus generally agreeing with Arnold's description of nearly round objects (certainly they they weren't square or triangular or T shaped) and he estimated that they were 30 ft in diameter, a value that is smaller than Arnold's estimate and smaller than the previously calculated value, suggesting that Johnson underestimated the size. (If he underestimated the distance above him he could also be likely to underestimate the size, since the size estimate is based on the angular size - the visually "apparent" size - and the estimated distance.) He also stated that the speed was "greater than anything I ever saw", which is consistent with the speed calculated from Arnold's sighting. He heard no noise. He observed that while the objects were in sight the needle of his compass waved from side to side. The waving stopped after the objects were out of sight.

The last statement in Johnson's letter provides important confirmation of Arnold's claim that he was able to see flashes of sunlight reflected from the objects. In the previous discussion of Arnold's sighting I pointed out that for the objects to reflect sun toward Arnold it would be necessary for some portion of each shiny object to tilt at least to an angle of about 60 degrees. The idea that the objects could tilt that much is supported by Johnson's claim that when he last saw the objects they were "standing on edge" while "banking in a cloud."

Aside from the apparent confirmation of Arnold's sighting, Johnson's sighting is unique as being the first to include a report of a physical effect during sighting (the apparent effect on the needle of his compass). This observation has led to calculations of the assumed magnetic field strength needed to affect a compass in this way from a distance of 1,000 ft or more. The resulting field strengths are immense.

Dr. Hynek, in reviewing all the sightings for Project Grudge in 1949, did not offer an explanation for this sighting. Dr. Menzel, on the other hand, did claim to have explained it (ref. 5). Menzel began his review of the sighting by pointing out that it occurred on the same day as Arnold's. However, he did not tell his readers that it took place at the same time in the afternoon, nor did he mention that Johnson was near Mt. Adams at the time and thus in the area where Arnold last saw the objects (flying past Mt. Adams). Thus the reader of his book would not have known, as Menzel probably did (Menzel had access to the Air Force files), that Johnson said he saw the objects reported by Arnold!

Menzel accepted Johnson's sighting as real (i.e., not a hoax, not a delusion), but explainable. After pointing out that Johnson observed the objects through his telescope for nearly a minute Menzel stated his explanation: "The behavior of the saucers... is distinctive

enough to label them as probably a true sighting. Bright reflections from patches of clouds were the most likely cause."

One wonders how Menzel could seriously suggest that Johnson could fail to realize that the objects were merely clouds after viewing them for many seconds through a telescope as they traveled by rapidly and were last seen banking into a cloud.

Menzel also dismissed the wobbling compass effect, arguing that in his excitement Johnson was not able to hold the compass steady. This is essentially saying that Johnson, who had about forty years of prospecting experience at the time, would not realize that the compass would wobble if he didn't hold it steady.

The bottom line is that Menzel's explanation makes no sense at all.

ESTIMATE OF THE MAGNETIC FIELD OF A SAUCER

(The following paragraphs outline a calculation of the magnetic field. It becomes quite technical and non-experts will probably want to skip it, noting only the final result stated here: if Fred Johnson's compass was affected by a magnetic field of a "flying saucer" at a distance of thousands of feet, then the magnetic field was positively huge, being equivalent to having an electric current of tens of megamp-turns flowing in a loop 10 or more meters in diameter. Such large fields could be produced in a reasonable way by using superconducting wire.)

Fred Johnson's observation of the wobbling compass can be used to estimate the strength of the source of the magnetic field that would be needed to cause the wobbling, assuming that the wobbling was indeed a result of a magnetic field from the saucers being superimposed upon the natural field of the earth. One can estimate the source strength in the following way. Before the saucers arrived the compass needle was being oriented by the earth's magnetic field of about 1/2 Gauss or 5E-5 Tesla (50,000 nT). Assume that a time-varying magnetic field with a strength roughly 1/5 of the earth's field, 1E-5 T, when superimposed on the earth's field but pointing in a different direction (i.e., not pointing north) would cause the compass needle to wobble or oscillate in direction. For simplicity also assume that the source of the magnetic field of a "flying saucer" can be represented as an electric current of some strength (amperes) flowing in a circle of some diameter, i.e., as a current dipole (a circular electric current or "current loop"). In the following calculation we assume the diameter of the current loop was 9 m (30 ft; Johnson's estimated size; this could be increased by a factor of 3, however, based on the size estimate from the Arnold sighting of over 80 ft; see above). The magnetic field was effectively measured by Johnson's compass at some distance from the current loop. Again for simplicity we assume that at some time during the sighting a saucer location and orientation was such that the compass was on the axis of the loop and at a distance of about 300 m (1,000 ft; Johnson's estimated distance; this could have been several thousand feet if, as Arnold thought, the objects were about as high as the top of Mt. Adams when they passed Mt. Adams). Since 300 m is much greater than the radius, R = 4.5 m, the equation for the field of a circular current loop, as measured at a distance z along the axis of the loop (z = 0 at the center of the loop), B(z) = 2Bo/(z^2 + R^2)^(3/2), can be approximated as B(z) = 2 Bo/z^3, where Bo is the characteristic strength of the field at the center of the loop. Inverting this equation and solving Bo = (1/2) B(z)z^3 with B(z = 300) = 1E-5T and z = 300 m yields Bo = 135 T-m^3. Bo is the product of the current times the loop area time 1E-7: Bo = 1E-7IA, where, for R = 4.5 m, A = 63.6 m^2. Hence the needed current is 135 x 1E7/63.6 = 2.1E7 amperes or 21 megamps (the source strength is 1.35E9 amp-m^2). The field strength at the center of the loop (z = 0, R = 4.5 m) would be about 3 T.

There are considerable engineering consequences of having this size magnetic field. The loop current required does not have to come from a single "turn" of the current around the saucer. Since the magnetic field depends upon the summation of fields from currents circulating around the loop, one can reduce the needed current by increasing the number of times it passes around the loop. For example, a 21 megamp single loop current is equivalent to 21 amperes if it makes 1 million passes around the loop. That is, an electric coil with a million turns of wire and 21 amperes flowing through it should be equivalent, magnetically, to a single turn carrying 21 megamps. Of course, a million turns around a 9 m diameter loop is a length of about 28 megameters. Using silver wire 1 mm in diameter with a resistance of about 0.02 ohms/meter would result in a coil resistance of about 2E4 ohms and require a voltage of 2E4 ohms x 21 amps = 420,000 volts. The power dissipated would be 21 x 420,000 = 8.8 megawatts. This would require a considerable cooling mechanism to keep the wires from melting and to radiate the thermal power away from the saucer. A much better way to explain the large field calculated above (other than the to assume the presence of monopolar magnetic sources on the saucer) is to assume that superconducting (zero or near zero resistance) wire is used to wind the current loops.

If the saucers were 3 times larger (30 m or about 100 ft in diameter) and 3 times farther (at a distance of 1,000 m or about 3,000 ft), Bo would be 27 times larger (for the same field strength at the compass, because of the cubic variation with distance) but the current would be only 3 times larger (because the loop area varies as R^2). Of course, these very simplified calculations probably do not provide us with the actual effective source strength of the

saucers, but they do demonstrate that the fields would have been extremely large to have affected Johnson's compass from a distance of 300 m or more.

.....

Fred Johnson's sighting holds a unique place in the history of the Air Force investigation.

Although, as I have stated, after the early fall of 1948 the Air Force investigators were under pressure to provide conventional explanations for all sightings because "interplanetary" was not an option, the fact is that some sightings resisted explanation. By the time Project Blue Book closed in 1969 the Air Force analysts at the Air Technical Intelligence Center at Wright-Patterson Air Force Base in Dayton, Ohio, had collected a total of about 13,000 sightings (1947-1969). Of these about 700 were left unexplained. Fred Johnson's unique place in history is based on the fact that his sighting is the first unexplained sighting!

But, you may ask, why isn't Arnold's sighting first, if Johnson saw the same things minutes (or less) after Arnold, and Johnson's sighting is unexplained? The answer is that due to sloppy record keeping and analysis (or by intent?) these two sightings were effectively separated (recall that Hynek did not know that Johnson's sighting occurred immediately after Arnold's) and hence one could not support the other. Then, when Arnold's sighting was determined by Hynek to be "replete with inconsistencies" it lost its credibility and was therefore explainable (as a mirage).

(Note: the Air Force has explained its failure to identify the 700 or so unexplained sightings as follows: there was not enough information to allow a positive identification. In other words, the Air Force says, "If we had had more information we could have identified these, too." Although this may seem like a reasonable explanation, the fact is that the unidentified sightings were the ones with TOO MUCH information, information that contradicted all known explanations. Johnson's sighting is a good example of this. If he had just said "I saw some strange objects fly over. I don’t know what they were," and left it at that, any reasonable explanation would be acceptable. Instead, he provided specific details. He described high speed, large angle tilting during flight, unusual semi-circular shape, tail wobbling back and forth, lack of noise and the apparent magnetic effect on his compass. What conventional aircraft or phenomenon had these characteristics in June, 1947? Answer: none. To explain this sighting one has to reject almost the complete description. No wonder it was left unexplained.)

CONCLUSION

Fifty years later it is clear that Kenneth Arnold’s (and Fred Johnson's) sighting contained sufficient information to demonstrate that strange objects, which were not man-made aircraft, were flying around in the atmosphere. Therefore it is a tribute to the effectiveness of the (yes, I’ll say it) propaganda put forth by the government and military, and widely promulgated by the press, the propaganda that all sightings have been or could be explained, that society in general has not accepted the idea that at least some reported UFOs/saucers are real, physical "hardware" objects of odd, non-aerodynamic shape and extreme dynamical capabilities.

It is resoundingly not a tribute to science that Dr. Menzel's reputation such weight with the scientific community that scarcely anyone analyzed his atmospheric explanations to see if they made any sense. (I am aware of only one review of his book that criticized Menzel's appeal to various rare atmospheric phenomena to explain all the sightings.) Instead his book was complemented for bringing a measure of sanity to the field of flying saucer research.

Hynek’s and Menzel’s “explanations” helped to establish the TRADITION which we live under today, that flying saucers/ufos, are all mistakes or hoaxes or delusions and certainly nothing to worry about. This TRADITION has a very important impact on present society... (so important that you could write a song about it, and have portly gentleman dancing around singing TRA-DI-TION....!)

However, careful analyses of sightings such as these by Kenneth Arnold and Fred Johnson show that this tradition is like a house of cards built on sand...
.... and it is crumbling.

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APPENDIX 1

RADIO INTERVIEW OF KENNETH ARNOLD, June 25, 1947

I thank Mike Christol for providing the audiotape and John Powell for transcribing it and posting it on the Encounters Forum of Compuserve. This is probably Arnold's the first radio interview.
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NEWSCASTER:
The nation, every newscaster, and every newspaper across the nation has made headlines out of it, and this afternoon we are honored,indeed, to have here in our studio this man, Kenneth Arnold, who, we believe, may be able to give us a first-hand account and give you the same on what happened.
Kenneth, first of all if you'll move up here to the microphone just a little closer, we'll ask you to just tell in your own fashion, as you told us last night in your hotel room, and again this morning, what you were doing there and how this entire thing started. Go ahead, Kenneth.

KENNETH ARNOLD:
Well, about 2:15 I took off from Chehalis, Washington, en route to Yakima, and, of course, every time that any of us fly over the country near Mt. Rainier, we spend an hour or two in search of the Marine plane that's never been found that they believe is in the snow someplace southwest of that particular area. That area is located at about, it's elevation is about 10,000 foot, and I had made one sweep in close to Mt. Rainier and down one of the canyons and was dragging it for any types of objects that might prove to be the Marine ship, uh, and as I come out of the canyon there, was about 15 minutes, I was approximately 25 to 28 miles from Mt. Rainier, I climbed back up to 9200 feet and I noticed to the left of me a chain which looked to me like the tail of a Chinese kite, kind of weaving and going at a terrific speed across the face of Mt. Rainier. I, at first, thought they were geese because it flew like geese, but it was going so fast that I immediately changed my mind and decided it was a bunch of new jet planes in formation. Well, as the plane come to the edge of Mt. Rainier flying at about 160 degrees south, I thought I would clock them because it was such a clear day, and I didn't know where their destination was, but due to the fact that I had Mt. Saint Helens and Mt. Adams to clock them by, I just thought I'd see just how fast they were going, since among pilots we argue about speed so much. And, they seemed to flip and flash in the sun, just like a mirror, and, in fact, I happened to be in an angle from the sun that seemed to hit the tops of these peculiar looking things in such a way that it almost blinded you when you looked at them through your plexiglass windshield. Well, uh, I uh, it was about one minute to three when I started clocking them on my sweep second hand clock, and as I kept looking at them, I kept looking for their tails, and they didn't have any tail. I thought, well, maybe something's wrong with my eyes and I turned the plane around and opened the window, and looked out the window, and sure enough, I couldn't find any tails on 'em. And, uh, the whole, our observation of these

particular ships, didn't last more than about two and a half minutes and I could see them only plainly when they seemed to tip their wing, or whatever it was, and the sun flashed on them. They looked something like a pie plate that was cut in half with a sort of a convex triangle in the rear. Now, I thought, well, that maybe they're jet planes with just the tails painted green or brown or something, and I didn't think too much of it, but kept on watching them. They didn't fly in a conventional formation that's taught in our army, they seemed to kind of weave in and out right above the mountaintops, and I would say that they even went down into the canyons in several instances, oh, probably a hundred feet, but I could see them against the snow, of course, on Mt. Rainier and against the snow on Mt. Adams as they were flashing, and against a high ridge that happens to lay in between Mt. Rainier and Mt. Adams. But when I observed the tail end of the last one passing Mt. Adams, and I was at an angle near Mt. Rainier from it, but I looked at my watch and it showed one minute and 42 seconds. Well, I felt that was pretty fast and I didn't stop to think what the distance was between the two mountains. Well, I landed at Yakima, Washington, and Al Baxter was there to greet me and he said ...[unintelligible]...

And, he told me, I guess I better change my brand, but he kind of gave me a mysterious sort of a look that maybe I had seen something, he didn't know, and well, I just kind of forgot it then, until I got down to Pendleton and I began looking at my map and taking measurements on it. And, the best calculation I could figure out, now even in spite of error, would be around 1200 miles an hour, because making the distance from Mt. Rainier to Mt. Adams, in, we'll say approximately two minutes, it's almost, well, it'd be around 25 miles per minute. Now allowing for air, we can give them three minutes or four minutes to make it, and they're still going more than 800 miles an hour, and to my knowledge, there isn't anything that I've read about, outside of some of the German rockets, that would go that fast. These were flying in more or less a level, constant altitude. They weren't going up and they weren't going down. They were just simply flying straight and level and I, I laughed ...[unintelligible]..., they sure must have had a tailwind. But it didn't seem to help me much. But to the best of my knowledge, and the best of my description, that is what I actually saw, and, uh, like I told the Associated Press, I'll, I'd be glad to confirm it with my hands on a Bible because I did see it, and whether it has anything to do with our army or our intelligence or whether it has to do with some foreign country, I don't know. But I did see it and I did clock it and I just happened to be in a beautiful position to do it and it's just as much a mystery to me as it is to everyone else who's been calling me the last 24 hours, wondering what it was.

NEWSCASTER:

Well, Kenneth, thank you very much. I know that you've certainly been busy these last 24 hours, 'cause I've spent some of the time with you myself, and I know that the press associations, both Associated Press and our press, the United Press, has been right after you every minute. The Associated and the United Press, all over the nation, have been after this story. It's been on every newscast, over the air, and in every newspaper I know of. The United Press in Portland has made several telephone calls here at Pendleton to me, and to you this morning, and from New York I understand, they are after this story, and that we may have an answer ...[unintelligible]... because, if it is some new type of army or navy secret missile, there would probably a story come out on it from the army or navy asking, saying that it is a new secret plane and that will be all there is to it, and they will hush up the story, or perhaps that we will finally get a definite answer to it.

I understand the United Press is checking on it out of New York now with the Army, and also with the Navy, and we hope to have some concrete answer before nightfall. We certainly want to thank you, Kenneth for coming into our studio. We feel very pleased that this news which is making nationwide news across the country, we are able to give our listeners over KWRC a first-hand report direct from you, of what you saw. And we urge our listeners to keep tuned to this station, because anytime this afternoon or this evening, and we get something on it on our United Press teletype, which is in direct communications with new York, Chicago, Portland, in fact, every United Press bureau across the nation, why, we'll have it on the air.

END.

An interview of Arnold by news commentator, Edward R. Murrow
Broadcast, 7 April, 1950:

ARNOLD: I never could understand at that time why the world got so upset about 9 disks, as these things didn't seem to be a menace. I believed that they had something to do with our Army and Air Force.

MURROW: On three different occasions, Mr. Arnold was questioned by military intelligence. They expressed doubt as to the accuracy of some of his reported observations...

ARNOLD: That's right. Now of course some of the reports they did take from newspapers which did not quote me properly. Now, when I told the press, they misquoted me, and in the excitement of it all, one newspaper and another on got it as ensnarled up that nobody knew just exactly what they were talking about, I guess.

MURROW: Here's how the name "flying saucer" was born...

ARNOLD: These objects more or less fluttered like they were, oh, I'd say, boats on very rough water or very rough air of some type, and when I described how they flew, I said that they flew like they take a saucer and throw it across the water. Most of the newspapers misunderstood and misquoted that too. They said that I said that they were saucer-like; I said that they flew in a saucer-like fashion.

MURROW: That was an historic misquote. While Mr. Arnold's original explanation has been forgotten, the term "flying saucer" has become a household word. Few people realize that Mr. Arnold has reported seeing these same strange objects in the sky on three other occasions....

Here is a transcript of the germane portion of the tape of Arnold's speech at the First International UFO Congress in Chicago, Illinois, held on or about June 24, 1977.

Transcribed by Bruce Maccabee in February, 2000.

He started by describing himself and flying and his business, etc. He spent some time talking about the dangers of his search for the Marine Transport. Clearly he had been flying around Rainier for some time before his "famous flight". This makes complete nonsense of Menzels' claims that Arnold misidentified weather phenomena such as fast moving clouds of snow, etc. from Mt. Rainier.

I gather from what he said that he flew westward while dropping in altitude in order to view the southeastward, southern and soutwestward flank of Rainier.

"As I came out below on this first sweep I passed over a little community of Mineral Washington, the pine trees there, and knew pretty much where I was. I made a turn at probably 2000 ft over Mineral, Washington and started climbing back slowly but steadily climbing, to gain sufficient altitude to go back on the high plateau again for another pass at this mountain. As I was making this turn and, of course flying directly toward Mt. Rainier, at about 9200 ft elevation... it was a beautiful day, in fact the plane was very stable, I didn't have to fight controls or weather or anything... a tremendous flash appeared in the sky and it lit up my whole aircraft, even it seem the cockpit of the airplane and I was rather startled.

I thought I hadn't seen a plane that was very close to me, or possibly it had been a military plane that had dove over my nose and the reflection of the afternoon sun against his wing surfaces had caused the flash. Now this just, in less than one tenth of a second, I think, went through my mind. I looked all around below me and looked ahead of me. And then the flash came again and, uh, this very, very bright flash, it was almost like an arc light, was coming from a group of objects far up to th north of Mt. Rainier, in the area of Mt. Baker, which is almost in a lie with Mt. Rainier and Mt. Adams. I observed a chain of very, very peculiar aircraft approaching Mt. Rainier very rapidly ,,,, I think I described them like the tail of a chinese kite. They seemed to be in an echelon formation However, in getting a look at them against the sky and against the snow of Mt. Rainier as they approached. I just couldn't discern any tails on them, and I had never, never observed an aircraft without a tail. Particularly these were of fairly large size and there was nine of them in number. I was good at counting things like this because I flew missions counting antelope, sheep , cattle, and what not in the course of my lifetime, and the first craft...

I kept searching for their tails. I was quite surprised that I couldn't find their tails. I was aware that the military was very clever at camouflage and I was, of course assuming all the time that these were military craft or at least military missiles. I was puzzled because the fomation of their echelon travel which was at 170 degrees, which is south, from north to south, following very closely to the Cascade Range, their formation as I observed it seemed to .... the first craft was at a higher elevation than all the rest of craft, which, of course, is not conventional ,military formation at all, in either this country or Russia or Germany or anything that I had ever heard of before. So I just assumed, in a flash, that they were some new type of military missile or jet and possibly remote controlled. They didn't fly like airplanes actually. This brilliant flash that came from their surfaces, which I assumed was from the sun reflection at first, would pulsate and they would flutter like this and sail. and they seemed to fly just as readily on edge as they did on a level. As I mentioned before they seemed like they were linked together in a sort of diagonal chain-like formation, similar to geese, but, uh (chuckle) they were not geese. I was very puzzled about that. However, I made a special note, they were all independent. Individually they were flying on their own, but every once in a while one of them would give off a flash like this and gain a little more altitude or deviate just a little bit from the echelon formation. And this went periodically on among the.. alternatingly, I should say, not in regular rhythm particularly,..., among all the nine craft I was observing.

When they approached Mt. Rainier's north edge, I could see they were to the west of Mt. Rainier, to me, which was a very good observation from my standpoint, because I was at right angles to them,. I determined that if they were missiles or whatever they were I was going to clock their

speed, or make an attempt to clock their speed. Now, around airports most pilots are always arguing about the speed of military craft, they're always arguing about the speed of their own planes. And I just thought, oh , it's a beautiful day and I've got a beautiful viewpoint here and I'm going to clock their speed even though I was closer to Mt. Rainier than to Mt. Adams, which was directly to the south and in their line of flight. I was going to clock their speed with my 24 hour clock which has a big sweep second hand on my instrument panel.

As the first one, putting its nose out of the southern edge of the snowfield of Mt. Rainier, my sweep second had was just approaching, if I remember it correctly, about one minute to three. I think it was just going over the three. And they kept, of course flying and...in between Mt Rainier and Mt Adams there is quite a lot of rough, high terrain, it's been named for many years goat ridge. I don't know way. Supposedly because it is very rough and very steep. But this goat ridge, as I later flew it, is approximately 5 miles long. Is in a line similar to this. I was approaching Mt. Rainier. I realized that my attempt to clock their speed absolutely accurately would have been hopeless because I was rapidly approaching Mt. Rainier at 9200 ft at about a hundred miles an hour, steadily climbing myself and or course they were passing from north to south and, uh, anyhow, what took place was that, as the first one was passing this goat ridge... as the first one actually passed the end of goat ridge the last one seemed to enter above the goat ridge. I made a guess that the formation of these peculiar aircraft was approximately 5 miles long. Now this estimation is purely an estimation because the goat ridge is quite irregular. It isn't running at exactly 170 degrees. But I was getting some kind of a judgement as to how long the formation was. These craft seemed to be climbing a little bit as they were following this 170 degree heading and I knew that I was on a level with them because thy were on a horizon with me, so my altimeter showed a little over 92 hundred feet, so they were flying at an elevation of about 92 hundred, probably a little less or a little more as they sort of undulated , if you want to call it that, as they flew.

As the... to be quite sure, as the last of this echelon formation of these strange aircraft actually passed Mount Adams, and to the best of my judgement were above a little bit, some of them, the head one was a little above Mt. Adams, I looked at my sweep second hand, and they had covered that distance of about 50 miles in a minute and 42 seconds. I didn't really, I knew they were flying really fast. I knew they were faster than our P-51's, or any planes I knew of militairly speaking, However, I didn't really try to figure out how many miles they were going.. Somehow I had a rather unusual feeling about it. Because of their size, and I judged their size to be probably, a hundred feet, their wingspan a hundred feet in diameter. And, of course, I was very puzzled by the fact that they didn't have tails. But I got a good liok at their image on the snow,. Now, when they gave off this flash they would appear to be round. When they turned lengthwise or flatwise to me they were very, very thin. And actually they disappeared behind a sharp projection on Mt. Rainier in the snow field to my eyesight. And, since I knew approximately where I was, flying of course toward the mountain, I knew where they had passed. I thought my judgement and my clocking could be within reasonable limits as to about how fast they were going. As they were going past this goat ridge the second from the last one seemed, it was not reflecting and it seemed to turn its rear end toward me. I guess that's the best expression I can use. And I could see that it was a very wraith-like looking thing, but it wasn't round at all. And the other ones gave me the impression they were rather like a tadpole. If you've ever seen a tadpole they have a little sort of a peak at their rear. But I couldn't quite positively determine if they were all the same design as this one I particularly noticed or whether they were ... Actually this one was a little larger , it seemed a little darker in color than the others and its wingspan seemed a little bit lighter. Of course a leader of a group of craft ot this kind would, of course, you would assume would probably be the first ship. This was second from the last one and the last ship I couldn't see too well because he was fluttering and jerking very rapidly.

The way that they performed was that, if there was a human being in them, they would have been made into hamburger at the first turn because they were going very fast and very erraticaly and they could change their direction almost instantly and it would have been awfully hard. The centrifugal must have been terrific, if there were human beings on them. This is the reason that gave me the impression that they must robotly guided missiles.

Anyhow I sort of lost interest in my search mission and I decided that maybe I ought to go to Yakima and report it. Now in my craft in order to save weight so I can make high altitude take offs with it on short airfields I don't carry a lot of radio gear. I just had a small, little radio that I could contact the control tower with. I didn't need expensive and elaborate gear and so I couldn't very well call Seattle tower, I couldn't call Takoma tower or McCord or anything. I just kept flying on the way they had traveled across the Cascade range and on to Yakima.

I felt positive in my own mind as I was continuing my flight to Yakima the forest observatories which run up and down the Cascades just couldn'tpossibly have missed seeing them because they were large and very distinct and there was quite a formation of them. However, I later found out that they ahd observed them but they had given their report not to the press or not to the public but of course to their superiors which, everything ends up eventually, I guess, in the Pentagon. I don't know.

So I landed at Yakima and I knew the pilots there. Al Baxter was the general manager of Central Aircraft. He was an examiner as well, and I explained this all to him and I said they didn't have any tails and I told him the approximate size and I mentioned the tremendous speed and acceleration they had and the seemingly effortless way they flew. And he was really quite puzzled. We had been friends for a long time and he knew that I wouldn't make such a report unless it was absolutely true. Many of the helicopter pilots in the area had come in that

afternoon and one of them mentioned, Well, Ken, I think you saw some of those guided missiles from Moses lake. I said I never heard of guided missiles from Moses Lake. I thought, well maybe that's what it is. And I felt satisfied that that's probably what they were."
////////////////////////////////////
(He continued his talk by describing what happened afterward. He made the 35 minute flight from Yakima to Pendleton Oregon. There were people at the airport. His story had preceeded him. While flying he had figured the speed. He had measured the distance and the minimum 39 miles distance in the time he measured. He got speeds above 1200 miles an hour. He said he stopped at Pendleton because he thought he should tell the FBI. He thought the objects could possibly be from Russia. Of course, no one had seen circular aircraft. At Pendleton he went to the FBI office but it was locked, so he went to the newspaper office and told the guy there he wanted to see the FBI. The newspaper man wanted to know what the story was. He had charts with him and described it to the newspaper man. Before the evening was over Arnold was beseiged and asked all types of questions. Many of the newspapermen would ask a bunch of questions, get a few answers and rush away to file their stories. Many of the stories ended up very distorted. These stories were reported in the press and then not too long afterward there were other reports. Before the night was over he had call from London, religious groups, etc....
Arnold thought maybe military took this way to introduce a new technology. Arnold said he had never read anything about strange things in the sky, other then "sightings" in the Bible.

After 3 days in Pendleton and getting no sleep and after all the sightings coming in he decided he was the only sane person in the whole damn town! "They must live a very interesting life" (laughter).
.....
.....

APPENDIX 2

SUMMARY OF BRIGHTNESS CALCULATIONS FOR
---OBJECTS
---MOUNTAIN
---PELICANS
by Bruce Maccabee

Arnold stated that he saw the bright reflections of the objects silhouetted against the snow of the distant mountains. It has been suggested that this makes no sense because it would be impossible to see reflections against the bright mountain snow. (Hence the bright reflections, if seen at all, must have been seen against the distant sky above the horizon.) However, I show below that it would be possible to see such reflections. It has also been suggested that the flashes Arnold saw were not from the objects but from the ice and snow on the mountains, particularly the ice and snow on Mt. Rainier. Does this make any sense? The calculations below show it doesn't. It has also been suggested that Arnold saw large birds..pelicans...and that there can be very bright sunlight reflections of sunlight from such birds. Does this make any sense? The calculations show it doesn't.

To be visible against the white snow the reflections from the objects would have to differ from the snow reflection in intensity and/or in color. The sun itself tends to be tinted toward yellow, whereas snow does tend to be white or sometimes bluish white. The reflection from the snow does modify the solar spectrum by a small but significant amount.

{An example of much greater spectral modification is the color of the clear sky which appears blue even though the light source, the sun, appears slightly yellowish white. The modification occurs because reflection of light from air molecules is larger at short wavelengths (blue) than for longer wavelengths (green, red). [For the expert: molecular density fluctuations occur within dimensions much smaller than the wavelengths of visible light; the strength of the reflection of light depends upon the magnitude of the a density fluctuation (the variation from the average density) and upon its physical size (the scale size of the region of air containing the fluctuation). Light is scattered more strongly at wavelengths comparable to the size of the fluctuation. The fluctuation scale sizes are so small compared to the wavelength of visible light that the scattering strength is proportional to the fourth power of the frequency so, for example, blue photons, which are about twice the frequency of red photos, would be scattered or reflected roughly 16 times more strongly than red photons. Hence the clear air appears bluish. When there are also aerosol particles... dust and tiny water drops... in the scattering comes from particles that are more nearly equal to light wavelengths and so the scattering is more equall spread across the spectrum, making the air look whitish blue.] The spectral modification for snow is only slight (certainly not as great as for clear air), but it doesn't take much blue "bias" in the spectrum to shift from a yellow tint to "pure" white. (Consider that "bluing" is used to restore "whiteness" to "yellowed" clothing.)}

If the reflective surface of the objects were color neutral, i.e., reflected all visible

wavelengths equally, then the reflected light color was the same as that of the sun and would have been slightly more yellow than the color of the snow. (We don't know whether the mirror surfaces might, themselves, have shifted the color slightly by not reflecting equally at all wavelengths, as for example the slightly reddish tint that comes from a copper mirror).

Hence from spectral considerations alone we cannot say that it was an "optical impossibility" for Arnold to see flashes of sunlight against the snow.

Of much greater importance is the intensity difference between the sunlight reflections from the objects and the sunlight reflection from the snow. Arnold compared the brightness of the flashes with the brightness of an arc light. This is an "extreme" comparison, as anyone who has looked at an arc light would know. Furthermore, whatever size the object was, IF SEEN AGAINST THE SNOW AS ARNOLD REPORTED, then it momentarily BLOCKED the view of the snow over an angular area equal to that of the object. Would Arnold notice the difference between having the snow unblocked and having it blocked by a flashing "object?" The answer depends upon the brightness of the sunlight reflected from the object and the brightness of the snow.

I have already pointed out that, since the object angular size was less than that of the sun (less than 1/2 degree) the amount of light reflected is basically the "fraction of the sun" that is seen (like looking at the sun through a small hole at some distance from your eye, a hole that is smaller than the angular size of the sun.) Below are calculations based on this to demonstrate that Arnold could have seen flashes over long distances (much farther than he could see a Pelican,..... for example!).

In this particular case we "only" have to compare the effective reflectivity of the mirror surface with that of the snow. Snow is not a specular reflector. For a specular reflector light is merely changed in direction. A "beam" of light that hits a mirror has its direction changed, but it stays "in a beam:" the light beam does not diverge any faster after hitting a FLAT mirror than it did before hitting the mirror. (Light does diverge faster if reflected from a curved surface. It is assumed here that whatever reflections were seen were from flat portions of the objects, or portions with very slight curvature.) The sun is so far away that light from a single "point" (a very small region) on the sun diverges very little at the surface of the earth. However the sun is not a point source. Instead, it is rather a collection of "points" which cover an area (the disc of the sun) and therefore there is a divergence introduced by the angular size of the sun, about 1/2 degree. To understand this, imagine that the sunlight passes through a small hole in a wall, say 1 cm in diameter, and hits a flat screen 1 meter away. (The distance to the screen should be much greater than the diameter of the hole.) Light from the left edge of the sun goes to the hole, through it and to a point of the screen. Light from the right edge goes also goes through the hole, but it is traveling in a slightly different direction as it comes from the sun, so it hits the screen at another location. These angular separation between these two points on the screen is the same as the angular separation of the points as seen when looking at the sun, 1/2 degree. Each point on the sun's disc creates a point of light on the screen thus making a complete disc of light on the screen...an image of the sun. The diameter of the disc is related to the distance from the hole to the screen as follows: the diameter of the disc divided by the distance from the hole to the screen is about 0.009 (9 milliradians, angular measure, where 17.45 milliradians is one degree, 0.009 mr is a bit more than 1/2 degree and there are 57.3 degrees per radian). To put it another way, you can calculate the diameter of the disc of light on the screen by multiplying the distance from the hole to the screen, D, by the angular size of the sun, 9 mr = .009: disc diameter = 0.009 x D. This is a "pinhole camera" image of the sun. The same would be true if the sunlight were bounced off a small, flat mirror onto a screen that is at a distance from the mirror that is much greater than the size of the mirror: the mirror would act like a small hole.

The first question discussed here, is how bright would flashes of sunlight from a mirror appear? After that calculations are done for snow, the horizon and pelicans.

BRIGHTNESS OF THE METAL FLASHES

Assume *for calculational purposes* that each object could be approximated as a flat (or very slightly curved) rectangle 30 m long by 20 m wide, with the long dimension along the direction of travel. (The result would be the same if a circular object of the same surface area were assumed.) The angular size would be about 1 milliradian as seen from Arnold's position about 20 miles away. (Angular size = actual size as measured perpendicular to the line of sight - called the "projected" size - divided by the distance.) When tilted (rotated about the long - 30 m - axis), the 20 m dimension is seen foreshortened by perspective and the 30 m dimension is not foreshortened. The area that is effective in "capturing" solar radiation for subsequent reflection, is length times the projected width, i.e., the width projected onto an imaginary surface that is perpendicular to the line connecting the object and the sun. The projected width is the width multiplied by the cosine of the angle between the surface normal (a line perpendicular to the flat surface) and the line to the sun. At the time of the sighting the elevation of the sun was 60 deg above the western horizon. (This corresponds to an angle of 30 deg down from the zenith (30 down from straight up)). The horizontal angle between Arnold and the objects was nearly zero (2 degrees at most) because he was nearly at the altitude of the objects. Hence, to reflect sunlight in his direction the objects had to be tilted just right to take sunlight, coming downward from an elevation of 60 degrees, and reflect it into the horizontal direction. In other words, the reflection had to turn the angle of a sunlight beam by 60 degrees. A "strange" thing about a mirror is this: if you measure the difference in direction of a reflected beam when you turn a mirror a small amount, say A degrees, then you find that the beam has changed direction by 2A degrees. That is, the direction (angle) of the

reflected light changes twice as fast as the mirror rotation (angle). If the flat surface of one of the objects was tilted 30 degrees toward the sun, so that the surface normal pointed toward the sun (zenith angle of 30 deg; zero degrees between the surface normal and the direction to the sun), the reflection would go directly back toward the sun. If the object were tilted another 30 degrees so that the angle between the direction to the sun and the surface normal was 30 degrees, the sunlight would be reflected at an angle 60 degrees away from the direction to the sun, i.e., into a horizontal direction, toward Arnold's plane. The projected size (width) of the mirror is determined by the 30 degree difference between the direction to the sun and the direction established by the surface normal. (The surface normal is "30 degrees lower than" the direction to the sun.) Hence the effective area of the mirror surface is 30m x (20m)cos(30deg) = 520 m^2.

The reflection from the mirror creates an expanding beam of light which illuminates Arnold's airplane. The area of the beam is at Arnold's airplane is determined by the angular divergence, i.e., the divergence of the sun, and the distance to Arnold's plane, about 20 miles. Uing the sun angular size of about 0.009 radians or 0.52 degrees, over a distance of 20 miles = 32 km, this projects to a beam diameter of about 0.009 x 32,000 = 290 m or a circular area of about 66050 m^2. Arnold's eyeballs were inside this beam. By determining how much light there was per unit area of this beam, and by estimating the area of one of Arnold's eyeballs (the area of the iris which lets light into his eyes) we can estimate how much light he saw coming from one of the objects. (Actually the calculation below uses the angular size of Arnold's eyeball at a distance of 20 miles, but the result is the same.)

The illuminance from the sun at the earth's surface is about 100,000 lumens/sq. m. = 1E5 lm/m^2 when the sun is around 60 degrees in elevation (from optics handbooks). (If you want to get an idea of just how bright this is, look at the sun on a clear day when it is about 60 deg above the horizon.) Multiply this by 520 m^2 and by 0.9 reflectivity of a metal surface to get the luminous flux or "luminous power" that is redirected toward Arnold's plane: 4.7E7 lm. At a great distance from the reflector (20 miles) this is spread throughout a beam of angular width equal to the angular size of the sun. The solid angle of this beam is 2 pi(1-cos(A/2)) where A is the full beam angle, or about 0.52 deg = 0.009 radians. Thus the solid angle of the reflected "beam" is about 6.5E-5 steradians (sr). (The fact that the reflector is a rectangle and not a circular surface is irrelevant at distances much, much larger than the size of the reflector.) It is not spread uniformly; there is an intensity peak in the center. However, if it is approximated as constant over the area the effective luminous intensity of the metal reflector is

Imetal = 4.7E7/6.5E-5 = about 7E11 lm/sr,

with the edge of the beam having intensities much less than this and the center having an intensity about twice this. (At Arnolds's eye it would be about half this because of the atmospheric attenuation. See below.)

How much of this light did Arnold's eyeball intercept? The luminous intensity should be multipled by the solid angle size of Arnold's pupil at a distance of 20 miles = about 32,000 m = 3.2E4 m and by the atmospheric transmission factor, approximately 1/2 (see below). The diameter of Arnold's pupil was probably about 2 mm = 2E-3 m (because he was looking into bright daylight sky) so the area of his pupil was about 3E-6 m^2. The solid angle of his eye in steradians is the area divided by the square of the distance which is about 3E-6/(3.2E4)^2 = about 3E-15 sr. Hence his eye intercepted a flux F (from a flat, rectangular surface), of about

Fflat,rectangular surface = [7E11 lm/sr]x(1/2)x[3E-15 sr] = about 1E-3 lm.

(NOTE: with the solar illuminance 1E5 lm/m^2 and the typical iris diameter of 2 mm, the amount of sunlight enetering an eye that is looking at the sun directly is about 1E5 lm/m^2 x 3E-6 m^2 = 3E-1 lm, or about 100 times the brightness calculated above for the reflection from the mirror. To put it another way, Arnold was seeing flashes of light equivalent to about 1/100th of the sun's brightness if this calculation is approximately correct.)

Because the light is not evenly distributed over the area but rather is peaked at the center of the "beam," when his eye was at the center might have received about twice as many lumens.

Of course this calculation is not to be considered "precise" because we don't know that the metal surfaces were perfectly flat (probably weren't), we don't know the reflectivity of the metal surface, the distance is probably not exactly correct and the atmospheric transmission may have been a bit more or less than 1/2.

Nevertheless, this calculation can be compared with the following one for reflection from snow.

BRIGHTNESS OF THE SNOW

For sunlight light reflected from the snow surface to Arnold there is a reflective coefficient divided by the solid angle into which all the radiation is scattered and then there is the factor that takes into account the divergence of the light from the point of scattering, 1/R^2. Let the reflective coefficient of snow be 0.7 (based on experimental results reported in Applied Optics). The effective luminous power or flux collected by patch of snow that is the same area as the projected mirror area above, 30mx20m x cos(30) = 520 m^2, is therefore about (1E5 lum/m^2) times (520 m^2) = 5.2E7 lm. This flux is multiplied by the reflectivity and is

spread out over a hemisphere. It is conventional to use a Lambertian directivity factor (cosine of the angle between the viewing direction and the perpendicular to the surface) for diffuse surfaces large enough to be resolved by the detection system (Arnold's eye) and certainly he could resolve the mountain. Assuming lambertian scattering, then the effective solid angle is pi steradians. Hence the luminous intensity of this patch of snow is estimated at

Isnow = 5.2E7 times 0.7 /(pi) = about 1E7 lm/sr.

Compare this with that for the metal, 7E11 lm/sr. (At Arnold's eye it would be about 1/2 of this because of atmospheric attenuation. See below.)

Arnold's eyeball, 20 miles away, intercepted only a small part of this. As before, multiply this number by the atmospheric transmission, 1/2 (see below), and by the solid angle of his pupil, 3E-15 sr. Hence his pupil intercepted a flux of about

Fsnow,rectangular area = (1E7 lm/sr)(1/2) x 3E-15 sr = about 1E-8 lm.

These calculations are only approximations. However, they are instructive. Clearly the 1E-3 lm into the eye from the flat mirror surface is much much greater than the 1E-8 lm from the patch of snow of the same size. The huge difference factor of 1/100,000 could be reduced if the mirror surface were not flat. But the big thing is that a diffuse reflection from an area won't be comparable to a specular reflection for the same sized area.

This is why Arnold could see the flashes against the white snow of Mt. Rainier. (I doubt that anyone ever accused Rainier of giving off "arc bright" flashes of light.)

BRIGHTNESS OF FLAT ICE

If one assumes there are perfectly flat ice surfaces, similar to the assumed metal surfaces, then one can calculate the brightness of a flat ice mirror of the same size as the metal, but specularly reflecting only about few percent of the light.

The low reflectivity of ice is a result of reflection from a DIELECTRIC material as opposed to a conductor. The transparent (to visible wavelengths) dielectric allows light penetration through the surface and therefore has appreciable transmission. The formula for normal (perpendicular) incidence is R = reflectivity of a dielectric = (n-1)^2/(n+1)^2 where n is the refractive index. Reflectivity changes with angles (and polarization), especially angles close to grazing incidence, but for the angles considered here, R is a valid value for reflectivity. For typical glass n = 1.55 +/- 0.05 and R is 0.046. This is the reflectivity at each surface or boundary. For plate glass the total reflection back is (0.046 from the first surface) plus [(0.954 transmission through the first surface) times (0.046 reflection at the second surface) times (0.954 transmission of light backwards through the first surface)] = 0.088. (Here I am ignoring the possibility of multiple-pass wave interference effects such as with a particular type of parallel plate interferometer.) For water/ice the refractive index is about 1.33 which gives a reflectivity of 2%. Furthermore, there is only a single surface; light that passes into the ice is scattered, not specularly reflected back where the ice joins the snow. The front surface reflection is the only specular reflection component. There could be further light bounced back by inclusions - bubbles, etc. - in the ice, but that would add a diffuse component. To account for this increased reflectivity assume that the effective specular reflectivity is 3%.

For a flat ice reflector of area 520 m^2 simply multiply the previous result for metal by 0.03: the intensity from ice is

Iice = 0.03 x 1E5 x 520/6.5E-5 in lm/sr = 2E10 lm/sr.

Compare this with Imetal above. The "ice flash" would be of lower intensity than the "metal flash" (about 1/50th to 1/30th of the metal flash). The flux into Arnold's eye would also be 1/50 to 1/30 of that calculated for the flat metal surface.

The above assumes a flat ice surface of the same size as the metal surface. That might be possible on a skating pond, but not likely on the side of a mountain. Instead, one might imagine a number of disconnected, small flat regions that might happen to be properly aligned to direct light toward Arnold's plane and could add together.

The possibility of light flashes from the from chance alignments of flat ice on Mt. Rainier is amusing but not necessarily directly related to Arnold's sighting. First, he reported seeing the bright flashes BEFORE the objects were silhouetted against the mountain and second, one would think that he would have seen light flashes from the mountain, if they existed, both before and after these (or any) objects happened to pass by, so it is hard to imagine that he would think that the flashes came from the objects and not from the mountain ice. (Note: I have seen video and photos of the mountain. None contain bright flashes from the ice.)

THE EFFECT OF ATMOSPHERIC TRANSMISSION

The primary effect of the passage of light through the atmosphere would be to decrease the light intensity. The optical extinction coefficient, b, enters into the equation I(R) = (Io)e^(-bR) where Io is the initial luminous intensity in lm/sr and b varies with altitude and atmospheric conditions. Assuming a standard clear atmosphere probably similar to what Arnold

was experiencing (not much haze) one can use a typical extinction "model" of the atmosphere:

b =[0.0153 e^(-z/7.26km) + 0.155 e^(-z/1.14km)]/km

At z = 9000 ft = 2.74 km, the equation gives b = 0.025/km. Use R = 20 miles = 32 km and get the attenuation exponent, bR = 0.025 x 32 = 0.78. Hence the transmission factor due to the atmosphere is expected to be e^(-0.78) = 0.46. In other words, a little more than half the light is lost to the atmosphere. This applies to the mountain snow and ice and to the objects (with slight variations for different distances).

BRIGHTNESS OF PELICANS SEVERAL MILES EAST OF ARNOLD

In presenting his argument that Arnold saw pelicans that would have been within a few miles of Arnold's plane, James Easton quoted an expert:

"Just look at the excruciating whiteness of the underwings of an adult white-headed gull such as a Herring or Glaucous-winged flying over snow on a sunny winter day."

Then James wrote:
"Of course Arnold's sighting wasn't as a ground observer and if birds were the source, any reflectivity wouldn't necessarily be confined to the underwings. "

To this I respond:
The reflectivity would more likely be confined to the upper surface (seen at a flat angle) since the hypothetical birds would have been a bit lower than Arnold and the glaciers were at a greater altitude (up to 14,000 ft). In this case the birds were not flying "over" the snow of Mt. Rainier and the observer was not looking upward at the "excruciating whiteness of their underwings. (If you want to see "excruciatingly bright" look at the reflection of the sun off a mirror the same size as the bird.)"

James wrote:
"I trust it is now proven that birds can be reflective, like a mirror, and this equally applies when considering other 'UFO' cases where that explanation may have been ruled out."

To which I respond:
A bird might cause a mirror-like reflection... but not as good as a metal mirror... under the following rather stringent condition: if the angle between the line from the observer to the bird and the line from the observer to the bright light source is very small (a degree or less). In other words, this might happen if the reflection occurs over a "grazing angle," in which case the observer sees the light source just above or just below the bird. This sort of reflection is called "forward gloss." It occurs with almost all surfaces at grazing angles. Even a black-top road can have a foward gloss. However this "mirror-like" reflection or forward gloss reflection did not apply to sun reflection in the Arnold case even if he were looking at birds because the direction to the hypothetical birds was OPPOSITE to the direction to the sun from Arnold's viewpoint. Specifically, if the birds were due east of him then the angle between his sighting line to the birds as compared to his sighting line to the sun was about 90+30 = 120 degrees, whereas forward glass occurs when the angle is a degree or less. In order for there to be a forward gloss reflection from birds east of Arnold there would have had to be a bright source of light east of Arnold. There was no such source, although Easton suggested that light reflected from Mt. Rainier or other mountains might have been such a source. Does this make any sense?

Since the birds had to be close to Arnold..within a couple of miles... they were far from Mt. Rainier. They were also about at Arnold's altitude and he was seeing them from the side.

Of course, light reflected from Rainier is NOT as bright as direct sunlight. Even the hypothetical "specular reflection from ice" would not be as bright because of the 3% (or less) reflectivity of ice. But because the light from Rainier would have been at grazing incidence it would have had an increased reflection coefficient toward Arnold (normal gloss or forward gloss) as compared to the backward reflection of the direct sunlight toward Arnold (which was basically "backscatter" of light).

Note, by the way, that the top of Rainier was several degrees above Arnold's horizon and therefore above the hypothetical birds. It is assumed that Arnold's sighting line was downward toward the backs (tops) of the hypothetical birds. Since most of the Glacier ice is above 9,000 ft then most of the light would have been glancing off the backs of the birds, not off their bellies. This is the "optimum" assumption for the pelican hypothesis. Of course, a consequence of this hypothesis is that there would have been bright reflections only when the birds were between Arnold and the mountain, contradicting his claim that he first saw the objects as a result of bright reflections when they were north of the mountain. Any other reflections would have been from lower mountains and would have been off the undersides of the birds.

AMUSING NOTE: If the sighting had taken place in the early morning instead of late afternoon then one MIGHT have justification for saying he saw bright forward gloss reflections of the sun from bird feathers **as long as the birds were "lined up with" the sun. However, even this hypothesis would not make much sense in the context of the whole history of the sighting because the birds would not make bright reflections at large angles from the morning sun. Recall that he saw reflections when the objects were both north and south of Mt Rainier, far from the required near perfect alignment between the birds and the mountain. (A sighting by Arthur C. Clarke has been cited as "proof" that bright reflections from birds could explain Arnold's sighting.

Clarke's sighting occurred just before sunset. The birds were in the direction of the sun at a slightly higher altitude. Clarke noticed the bright reflections but couldn't, at first, see the birds. So initially the reflections were unexplained. It made him think of a reflection from a "flying saucer. " Then he noticed the birds after they had moved away from the sun and realized that he had seen bright reflections from the bellys of the birds. His observation was surely unusual, but nevertheless completely understandable: it occurred under conditions optimum for a bright forward gloss reflection from the feathers. Obviously Clarke's sighting has no bearing on Arnold's for which no forward gloss reflection from the sun was possible.)

To test this hypothesis, let's consider the forward gloss to find out how bright such a reflection might be. Assume a hypothetical bird was "aligned" with Mt. Rainier such that light from the mountain bounced off the bird wings. To get a good forward gloss the angle between Arnold's sighting line to the bird and Arnold's sighting line to the light source - the mountain - should be no more than a couple of degrees. Assume a bird wing 1 m long and 10 m wide. Arnold would have been looking along the length of the extended wings since they were flying across his line of sight, so he would see a greatly foreshortened wingspan. Assume they were 2 km (about 1 1/4 miles) away and at a depression angle of 3 degrees. From Arnold's perspective it would look like a rectangle 1 m long (horizontal length measured left to right, i.e., in the direction of flight, from his perspective) by (10 m sin 3) = 0.52 m in vertical extent (as long as the wing surface was perfectly horizontal. The angular size would be 1/2000 by 0.52/2000 or 0.5 mr by .26 mr (mr = milliradians), or not too dissimilar from what we have assumed were the angular sizes of the objects he actually reported.

The question now is, what is the maximum brightness that the bird could appear? Of course, with the bird between Arnold and the mountain, Arnold would be looking toward it and seeing the mountain in "all its brilliance." The bird would appear below the upper part of the mountain and the forward gloss reflection would be light reflected from the top of a bird (which he didn't recognize as a bird). Since the hypothetical bird was almost as far from the mountain as was Arnold at the time of the sighting, the amount of light reaching the bird to be redirected by reflection toward Arnold was just a bit greater than the light reaching Arnold directly. But, after reflection from the bird the light would have to travel the remaining distance to Arnold. Thus the atmospheric absorption would be identical.

Hence the light reflected from the bird could be NO BRIGHTER THAN the light reaching Arnold directly from the mountain. In fact, because the bird is not a perfect reflector, despite forward gloss, the amount of light directed toward Arnold would be less than the amount reaching him directly from the mountain. (Also, there would be added divergence due to reflection from the bird because of "pinhole camera" effect applied to the bird-sized reflector of light from the large-area source, Mt. Rainier.)

The conclusion is that light from the mountain reflected from the bird would not be any more impressive than light from the mountain itself, and probably less. Moreover, each time the bird brought its wings downward or upward the "horizontal mirror" effect would be broken...and you know what happens when you break a mirror (bad luck!).

Forgetting the forward gloss reflection of mountain top light, let us find out how bright the birds would have been as lit normally by the sun behind (and above) Arnold. Suppose we have birds at 2 km, lit by the sun and with diffuse white surfaces (but no glint or normal/forward gloss). As with the snow calculation above, one can assume 1E5 lm/m^2 on the birds surface. It is kind of difficult to determine just what the cross-sectional area projected onto the line of sight to the Arnold would be since they were basically at his altitude and so he was looking at their sides when they were closest. Let's be generous and assume that the bird is a 1 m^2 diffuse reflector. Therefore it reflects 1E5 lumens, but not into the 1/2 degree beam that a mirror would do, but into an effective solid angle of pi steradians (assumption of lambertian reflection). Hence the maximum possible intensity of a bird, which we obtain by assuming unit diffuse reflectivity (better than the best white paper), would be (1E5 lm/m^2)(1 m^2)/ pi lm/sr = 3E4 lm/sr. The transmission to Arnold's eyeball is given by e^(-.025 x 2km) = 0.95. Hence the intensity of a bird is

Ibird = (1E5 lm/m^2)(1 m^2)(1)(0.95)/pi = 3E4 lm/sr

This is the maximum for a clear bird. For a typically "dirty bird the brightness would be less. The area of his eyeball was 3E-6 m^2 so the solid angle of his eyeball was (3E-6 m^2)/(2000 m)^2. Therefore we have entering his eyeball

Fbird = 3E4 (3E-6/2000^2) = about 2E-8 lm.

This can be compared with the previous calculation of the lumens into Arnold's eye from a flat metal mirror of tens of meter size at the distance of Mt. Rainier, about 0.001 lm (see above). If you shrink the metal mirror area by 100, making the equivalent flat mirror surface dimension only meters in size rather than tens of meters, the intensity from the metal mirror is still about 1000 times greater than expected for birds at about 1.25 miles (2 km) distance.

Oddly enough, the number of lumens expected from a 1 m^2 bird at 2 km is comparable to the number expected from the tens of meter size area (520 m^2) of snow on the mountain 1E-8 (see above). That means that the bird brightness would be comparable to, maybe a bit brighter than, the snow brightness from Arnold's perspective. They certainly would not appear as bright flashes against the snow. This assumes 100% reflectivity of the white surfaces of the birds. Of course, this is unreasonable, so the bird brightness calculation here is too large.

SKY BRIGHTNESS AT THE HORIZON

Arnold was looking into a bright field of light, namely the horizon sky at his altitude. I have already estimated the luminous intensity of the the snow on Mt. Rainier. But Arnold was looking mostly at the white horizon sky if these objects were at his altitude or several thousand feet above or below. (The horizon is almost always white because of aerosol particles which are larger than the wavelength of visible light. Looking down from the horizon one sees ground. Looking up, the color of the sky changes from white to pale blue to deep blue directly overhead.... WHEN CLEAR, of course!).

I have a research article which indicates that when the sun is at 42 degrees elevation in the west and the person is looking east from an altitude of 9000 ft the luminance,B, of the sky at the horizon is in the neighborhood of B = 7500 lm/sr/m^2. The luminance decreases if you look up or down from the horizon. This number can be used to calculate the flux received by Arnold's eye from the horizon light in the following way.

The general definition of luminance or "brightness" is the flux per unit area of the source projected onto the line of sight per unit solid angle of the receiver. The solid angle of the receiver depends upon area of the receiver (e.g., aperture size on a camera) and the distance from the source to receiver. That is, the flux collected by the receiver is B x (projected area of source) x (solid angle of receiver aperture). But when one is looking at the sky this raises the questions (1) how far is the sky (the distance from the source is needed to calculate the solid angle of the receiver aperture) and (2) which square meter of the sky should I use for the area of the sky? To answer these quesions one begins by writing the standard equation for calculating flux received by an aperture of area Aa from a large angle (NOT a point) source of brightness B and (resolved) area As at distance R: F = B x (Aa/R^2) x (As). Notice that the equation gives the same result whether R^2 is under the Aa or moved to be under As. Upon moving R^2 one has: F = B x (Aa) x (As/R^2). Now we have numbers that can be measured because (As)/R^2 is, by definition, the solid angle of the source AS "SEEN" by the receiver (aperture). The solid angle of the source is like a "cone of acceptance" of light projecting from the aperture of the receiver out into the sky. This can also be considered to be the solid angle of a "pixel" on the focal plane. The source area, as projected onto the line of sight, must be large enough to completely fill the pixel angle. The light coming into the aperture over this cone angle is the integral over light sources "out there" in the sky. It is assumed that throughout the cone angle the brightness is constant.

Therefore the way to use this information is to assume a certain angular size resolution element in Arnold's eyeball and use this to calculate the "cone of acceptance" or solid angle of sky that would contribute light to that resolution element. Then multiply this by the area of his pupil to get the number of lumens hitting that resolution element. If we assume a resolution ("pixel") size of 0.6 mr = 0.034 degrees (corresponding to about 20 meter resolution at 20 miles) the solid angle is 2 pi (1-cos(0.034/2)) = 2.2E-7 steradians (where 0.034 is the "cone angle"). The area of Arnold's pupil was assumed to be about 3E-6 m^2 so the lumens entering his eyeball and hitting a resolution element would be only

Fsky = flux from sky at the horizon = 7500 x 2.2E-7 x 3E-6 = 5E-9 lm.

It is amusing...and somewhat gratifying....to note that this number of lumens is comparable to what was calculated before, 1E-8 lm, for snow on the mountain using a large surface area (520 m^2), an area that would be somewhat larger than the effective pixel size. One expects these to be comparable because the distance to the mountain is considerable and in each case the source is sunlight scattered from a diffuse surface (the sky has lots of tiny diffuse surfaces...aerosol articles). (NOTE: the snow would appear brighter than the sky to an observer who is close to the mountain. As one gets closer to the mountain the lumens from the sky stays the same (!) since the solid angle of acceptance doesn't change, but the number of lumens from the mountain increases as the range shrinks because the atmospheric attenuation decreases.)

FLASH BLINDED? HOW BRIGHT WAS THE SOURCE?

Arnold compared the brightness with that of an electric arc and hinted at temporary "flash blindedness," which one does get from looking at an arc welding operation without the proper optical filters (welders goggles). I carried out a series of experiments on solar reflections from distant mirrors and can confirm that even from a small mirror surface the reflection can be very brilliant.

At the very least, Arnold's description of the brightness of the flash indicates it was much greater than the brightness of the horizon sky or mountain. That means, based on the calculations above, that the number of lumens into his eye from the flash was much larger than 1E-8. I don't have data on the illuminance necessary to "flash blind" a resolution element of the eye. Assume for working purposes that it is a flux of Fb lumens. Then with the eye pupil 3E-6 m^2 and the distance to the source being R = 20 miles = 32 000 m, the luminous intensity of the flash source, Ifs, is found by inverting the equation, Fb = (Ifs/R^2)(Area)T = (Ifs/32000^2)(3E-6)(1/2), where T is the atmospheric transmission over range R. Solving for Is:

Ifs = Fb(32000^2)/(3E-6 x 1/2) = (6.8E14)Fb = about 7E14 Fb

If Fb were as low as 1E-8, that is, comparable to the flux into Arnold's eyeball from the sky brightness or the distant snow, as calculated above (and we know that sky brightness can produce "spots before the eyes" that you can observe by closing your eyes or going into a dark

room, but not while looking at the bright sky), then Ifs would be around 7E6 lm/sr. However, to produce "spots before your eyes" that can be "dense" enough to wipe out vision in full daylight (over a resolution area), B would likely have to be 10 or 100 times as intense as the skylight. That would put Ifs into the range of 7E7 to 7E8 lm/sr. Assuming 4 pi radiation from the source this puts the number of lumens radiated at about 9E8 to 9E9. High pressure arc lamps are about the most efficient visible light sources and operate at luminous efficiencies on the order of 50 lm/electrical watt input. A source with this efficiency would have to be driven by about 1.8E7 to 1.8E8 watts to create the number of lumens. I don't know what a welding arc puts out (not listed as a typical light source!), but probably not a lot more than a xenon high pressure short arc lamp. (Note: the luminous efficiency of light itself is abou 680 lumens per watt of optical radiation within the visible range. This is tricky since the spectral response of the eye is involved.)

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WOULD THE METAL OBJECT FLASHES HAVE BEEN VISIBLE
AT THE DISTANCE OF Mt. ADAMS??

Arnold reported that the 'planes' remained visible by the flashes of reflected sunlight for some seconds after they passed Mt. Adams, perhaps for as far away as 50 miles.

The question was raised, how feasible is this and if factual, what might it tell us about the objects' size and reflectability?

This is an interesting point which indicates that the light from the objects, whether solar reflections or generated by the objects themselves, must have been very intense. However, the idea that he could see them as far as Mt Adams about 40 miles south is consistent with his claim of "blinding brightness," or whatever. If they were "extremely bright" as seen near Mt Rainier about 20 miles away, then they certainly were bright enough TO BE SEEN (although not bright enough to cause temporary "spots before his eyes) at 40 miles. The luminous flux received by his eyeball is proportional to the (atmospheric transmission)/distance^2. Previously I gave the atmospheric transmission factor as 0.46 for 32000 km (20 miles). At twice that distance the transmission is about 0.2 or about 1/2 of the previous transmission. The distance was doubled so the 1/R^2 factor is 1/4 of the previous. Thus the flash brightnesses of the previous calculations should be multipled by about (1/2) 1(4) = 1/8. The flashes were so bright at 20 miles that they would still be visible even if reduced in intensity by a factor of 8. Hence I conclude that they would still be visible at Mt. Adams..... unlike pelicans, of course.